



GREELEY AND HANSEN

741 North Grand Avenue, Suite 308
Waukesha, Wisconsin 53186
p 262 290 2120
www.greeley-hansen.com

April 13, 2018

Kelly Zylstra, P.E.
Operations Manager
Waukesha Water Utility
115 Delafield Street
Waukesha, WI 53187

Subject: Great Lakes Water Supply Program
Task 4-100 D2 Route Study: Milwaukee
GWA PM/CM DEL 4-100 D2 Route Study: Milwaukee

Dear Ms. Zylstra:

In accordance with Task 4-100 Route Study and Pipelines of our Agreement, we are hereby delivering via the Great Water Alliance SharePoint site a draft of Deliverable 4-100 D2 Route Study: Milwaukee for your review and comment.

The purpose of this deliverable is to identify a preferred route that would be used to supply Waukesha with a new, sustainable water supply from a water supply connection to the City of Milwaukee (Milwaukee). Route alternatives were compared based on economic and non-economic criteria with input from meetings and workshops. A steady state hydraulic analysis was also conducted to evaluate the requirements to deliver flow at demand conditions and support the economic and non-economic comparison of route alternatives.

The preferred route will be used as a basis for the further development of the preliminary and detailed design of the Water Supply Pipeline as part of Phase 2 of the Program.

Should you have any further questions or concerns, please let me know.

Yours very truly,

Greeley and Hansen LLC

Program Manager

NBS/kmb

Encl (2): Deliverable 4-100 D2 Route Study: Milwaukee (electronic version)
Deliverable 4-100 D2 Route Study: Milwaukee (flash drive)

cc: Deliverable 4-100 D2 file

Great Lakes Water Supply Program



GREAT WATER
ALLIANCE



DRAFT 4-100 D2 Route Study: Milwaukee

April 2018



TABLE OF CONTENTS

EXECUTIVE SUMMARY.....	ES-1
SECTION 1	Introduction..... 1-1
1.1	Background and Purpose 1-1
1.2	Route Study: Oak Creek..... 1-3
1.3	Scope of Services..... 1-3
SECTION 2	Data Collection 2-1
2.1	Data Sources 2-1
2.2	Milwaukee Route Study Area..... 2-2
2.3	Points of Connection..... 2-2
2.3.1	Water Supply Pipeline Connection to Water Supplier..... 2-3
2.3.2	Water Supply Pipeline Connection to Reservoir and Booster Pumping Station 2-4
2.3.3	Water Supply Pipeline Connection to Waukesha Water Utility Distribution System 2-5
2.4	Property and Right-of-Way Information 2-6
2.5	Recent and Planned Regional Transportation Projects 2-6
2.6	Typical Cross Sections 2-6
2.7	Special Crossings 2-12
SECTION 3	Route Alternative Development..... 3-1
3.1	Route Alternative Selection for Route Study..... 3-1
3.1.1	Panel 1 – 60th Street to Interstate 41 3-2
3.1.2	Panel 2 – Interstate 41 to Moorland Road 3-9
3.1.3	Panel 3 – Moorland Road to Booster Pumping Station 3-13
3.1.4	Route Alternatives for Route Study 3-16
3.2	Description and Discussion of Route Alternatives M1, M2, and M3 3-18
3.2.1	Route Alternative M1 3-18
3.2.2	Route Alternative M2 3-18
3.2.3	Route Alternative M3 3-19
SECTION 4	Route Alternatives M1, M2, and M3 Hydraulic Analysis 4-1
4.1	General..... 4-1
4.2	Water Demands..... 4-1
4.2.1	Approved Diversion 4-1
4.2.2	Historical Demands 4-1
4.2.3	Diurnal Demand..... 4-4
4.2.4	Demands Evaluated 4-5

TABLE OF CONTENTS

4.3	Hydraulic Analysis Method	4-5
4.3.1	Concept Overview	4-5
4.3.2	Assumptions and Criteria.....	4-6
4.3.3	Pipeline Size.....	4-7
4.3.4	Steady State Hydraulic Conditions	4-10
SECTION 5	Evaluation of Route Alternatives M1, M2, and M3	5-1
5.1	Non-Economic Evaluation	5-1
5.1.1	Total Pipeline Length.....	5-1
5.1.2	Special Crossings.....	5-2
5.1.3	Geotechnical Conditions.....	5-6
5.1.4	Contaminated Materials.....	5-14
5.1.5	Wetlands.....	5-15
5.1.6	Waterways.....	5-16
5.1.7	Endangered Resources.....	5-19
5.1.8	Cultural Resources.....	5-20
5.1.9	Agricultural Resources.....	5-20
5.1.10	Maintenance of Traffic Requirements.....	5-22
5.1.11	Recent and Planned Regional Transportation Projects.....	5-23
5.1.12	Stakeholder Feedback.....	5-24
5.1.13	Real Property and Easement Requirements	5-25
5.1.14	Constructability	5-27
5.1.15	Non-Economic Evaluation	5-29
5.2	Economic Evaluation	5-29
5.2.1	Opinions of Probable Construction Cost.....	5-29
5.2.2	Life Cycle Pumping Costs.....	5-31
SECTION 6	Preferred Route	6-1
6.1	Development of Key Performance Indicators	6-1
6.2	Route Alternatives M1, M2, and M3 Scoring	6-2

TABLE OF CONTENTS

LIST OF TABLES

Table ES-1 Class 4 Opinions of Probable Construction Cost for Route Alternatives.....	ES-4
Table ES-2 Key Performance Indicator Summary	ES-5
Table ES-3 Triple Bottom Line Evaluation	ES-6
Table 2-1 Data Review Summary	2-1
Table 2-2 Recently Completed and Planned Regional Transportation Projects Summary	2-6
Table 2-3 Municipal Pavement Design Standards	2-8
Table 3-1 60th Street to Interstate 41 – Route Alternative M1	3-7
Table 3-2 60th Street to Interstate 41 – Route Alternatives M2 and M3	3-9
Table 3-3 Interstate 41 to Moorland Road – Route Alternative M2	3-11
Table 3-4 Moorland Road to Booster Pumping Station – Route Alternative M1	3-15
Table 3-5 Moorland Road to Booster Pumping Station – Route Alternative M2	3-15
Table 3-6 Moorland Road to Booster Pumping Station – Route Alternative M3	3-16
Table 4-1 Demand Conditions per Final Decision.....	4-1
Table 4-2 Water Supply Pipeline Size, Water Supply Pumping Station to Booster Pumping Station	4-8
Table 4-3 Water Supply Pipeline Size, Booster Pumping Station to Waukesha Water Utility Distribution System	4-9
Table 4-4 Head and Power Required at Pumping Stations for Maximum Day Demand over 18-hour Pumping Schedule.....	4-10
Table 5-1 Total Pipeline Length	5-1
Table 5-2 Special Crossings	5-2
Table 5-3 Trenchless Crossing Characteristics, Route Alternative M1	5-3
Table 5-4 Trenchless Crossing Characteristics, Route Alternative M2	5-4
Table 5-5 Trenchless Crossing Characteristics, Route Alternative M3	5-5
Table 5-6 Shallow Bedrock	5-6
Table 5-7 Dense Soils.....	5-8
Table 5-8 Organic Soils.....	5-8
Table 5-9 Shallow Groundwater.....	5-11
Table 5-10 Corrosive Soils.....	5-11
Table 5-11 Contaminated Materials	5-15
Table 5-12 Mapped and Photo-Interpreted Wetlands	5-16
Table 5-13 Waterways	5-16
Table 5-14 Endangered Resources	5-19
Table 5-15 Cultural Resources	5-20
Table 5-16 Agricultural Resources	5-22
Table 5-17 Transportation.....	5-23
Table 5-18 Recent and Planned Regional Transportation Projects	5-24
Table 5-19 Real Property and Easement Requirements.....	5-26
Table 5-20 Right-of-Way and Ownership, Route Alternative M1	5-26
Table 5-21 Right-of-Way and Ownership, Route Alternative M2	5-26
Table 5-22 Right-of-Way and Ownership, Route Alternative M3	5-27
Table 5-23 Easement Requirements, Route Alternatives M2 and M3	5-27
Table 5-24 Non-Economic Evaluations Summary.....	5-29
Table 5-25 Class 4 Opinions of Probable Construction Cost for Route Alternatives.....	5-30
Table 5-26 Life Cycle Pumping Costs	5-31

TABLE OF CONTENTS

Table 6-1 Key Performance Indicator Summary	6-1
Table 6-2 Metrics Delineated into Key Performance Indicators	6-2
Table 6-3 Triple Bottom Line Evaluation for the Route Alternatives M1, M2, and M3	6-3

LIST OF FIGURES

Figure ES-1 Route Alternatives M1, M2, and M3 – Water Supply Pipeline.....	ES-3
Figure ES-2 Preferred Route – Water Supply Pipeline	ES-7
Figure 1-1 Water Supply System Diagram.....	1-2
Figure 2-1 Milwaukee Route Study Area	2-2
Figure 2-2 Anticipated Point of Connection to Water Supplier	2-3
Figure 2-3 Water Reservoirs and Booster Pumping Station Location	2-4
Figure 2-4 Waukesha Water Utility Distribution System Connection	2-5
Figure 2-5 Typical Single Pipe Sections under Pavement and Landscape.....	2-7
Figure 2-6 Typical Common Corridor Section under Pavement.....	2-10
Figure 2-7 Typical Common Corridor Section under Landscape	2-11
Figure 3-1 Route Sub-Alternatives Panels Key Map.....	3-1
Figure 3-2 Route Sub-Alternative Nomenclature	3-2
Figure 3-3 Potential Interstate 41 Special Crossing Locations.....	3-3
Figure 3-4 Average Daily Traffic Counts Panel 1 of 3 – 60th Street to Interstate 41.....	3-5
Figure 3-5 Existing Utilities Panel 1 of 3 – 60th Street to Interstate 41	3-6
Figure 3-6 Route Sub-Alternatives Panel 1 of 3 – 60th Street to Interstate 41	3-8
Figure 3-7 Route Sub-Alternatives Panel 2 of 3 – Interstate 41 to Moorland Road	3-10
Figure 3-8 Potential Interstate 43 Special Crossing Locations.....	3-12
Figure 3-9 Route Sub-Alternatives Panel 3 of 3 – Moorland Road to Booster Pumping Station.....	3-14
Figure 3-10 Route Alternatives M1, M2, and M3 – Water Supply Pipeline	3-17
Figure 4-1 29-Year Waukesha Water Demand History – January 1, 1988 through December 31, 2016.....	4-2
Figure 4-2 10-Year Waukesha Water Demand Frequency – January 1, 2007 through December 31, 2016.....	4-3
Figure 4-3 Diurnal Demand Curve	4-4
Figure 4-4 Water Reservoirs to Waukesha Water Utility Distribution System Connection Diagram	4-7
Figure 4-5 Hydraulic Grade Line and Pressure for Water Supply Pipeline	4-11
Figure 5-1 Shallow Bedrock.....	5-7
Figure 5-2 Dense Soils.....	5-9
Figure 5-3 Organic Soils	5-10
Figure 5-4 Shallow Groundwater	5-12
Figure 5-5 Corrosive Soils.....	5-13
Figure 5-6 Wetlands.....	5-17
Figure 5-7 Waterways	5-18
Figure 5-8 Cultural Resources	5-21
Figure 6-1 Preferred Route – Water Supply Pipeline	6-5

TABLE OF CONTENTS

LIST OF APPENDICES

Appendix A – Route Alternatives M1, M2, and M3 Descriptions and Discussions
Appendix B – Geotechnical Soil Analysis Technical Memorandum *(Included Electronically)*
Appendix C – Contaminated Materials Technical Memorandum *(Included Electronically)*
Appendix D – Wetlands and Waterways Technical Memorandum *(Included Electronically)*
Appendix E – Endangered Resources Technical Memorandum *(Included Electronically)*
Appendix F – Cultural Resources Technical Memorandum *(Included Electronically)*
Appendix G – Agricultural Resources Technical Memorandum *(Included Electronically)*
Appendix H – Transportation Assessment Technical Memorandum *(Included Electronically)*
Appendix I – Route Alternatives M1, M2, and M3 Preliminary Horizontal Alignments *(Included Electronically)*
Appendix J – Workshop and Meeting Summaries *(Included Electronically)*

PROGRAM TEAM MEMBER CONSULTANTS:



KEVIN RICHARDSON CONSULTING

EXECUTIVE SUMMARY

The Waukesha Water Utility (WWU) provides water treatment and distribution services to the City of Waukesha (Waukesha). The St. Peter Sandstone aquifer, which has been the primary source of drinking water for not only Waukesha, but for communities throughout the Midwest, is being depleted in Southeast Wisconsin. This is due in large part to a natural layer of shale rock that restricts groundwater recharge. Depletion of the St. Peter Sandstone aquifer has also caused increases in the concentrations of radium and other contaminants. As a result, Waukesha needs a long-term, sustainable alternative to its existing water supply to protect public health.

In October 2013, following study efforts and public engagement, Waukesha resubmitted its Application for Lake Michigan Diversion with Return Flow (Application) to the Wisconsin Department of Natural Resources (WDNR). In it, Lake Michigan water was determined to be the only reasonable sustainable source of water that protects both the environment and public health. WDNR concurred that Waukesha's proposal met the criteria of the Great Lakes-St. Lawrence River Basin Water Resources Compact (Compact) and submitted the Application to the Great Lakes-St. Lawrence River Basin Water Resources Council (Compact Council) for review.

The Compact Council was established in 2008 when the Compact became federal and state law in the United States. The Compact Council is comprised of eight governors from the Great Lakes states: Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin. The purpose of the Compact is to provide a legal precedence through which to manage and protect the Great Lakes-St. Lawrence River Basin per the governors' pledge with the premiers of Ontario and Quebec.

In its Final Decision, dated June 21, 2016, the Compact Council unanimously approved Waukesha's Application to source water from Lake Michigan. WWU subsequently commissioned a team of consultants to implement the Great Water Alliance (Program) to transition Waukesha's water supply from groundwater to Lake Michigan water. The purpose of the Program is to plan, design, construct, and commission infrastructure with a 100-year useful life necessary to transition Waukesha's water supply from groundwater to Lake Michigan water. The Program is the first for a community in a county straddling the Great Lakes-St. Lawrence River Basin to access Great Lakes water through the Compact. Successful implementation of the Program will set industry precedents for solving water quality and water scarcity challenges for at-risk water supplies in other Great Lakes communities.

As part of the Program, approximately 12 to 14 miles of transmission main (referred to as the "Water Supply Pipeline") with pumping facilities, water reservoirs, and chemical treatment will deliver potable water to Waukesha from a connection to a water system supplied with Lake Michigan water. Approximately 23 miles of main (referred to as the "Return Flow Pipeline") with pumping facilities located at Waukesha's Clean Water Plant (CWP) are required per the Final Decision to achieve a net zero water balance in the Great Lakes-St. Lawrence River Basin by discharging highly treated effluent to the Root River, which ultimately discharges into Lake Michigan.

The purpose of this Route Study (Study) is to identify a preferred route to supply Waukesha with a new, sustainable water supply from a water supply connection to the Milwaukee Water Works (MWW) distribution system in the City of Milwaukee (Milwaukee). Refer to the Draft Route Study: Oak Creek (4-100 D1) for details regarding the preferred route for the Return Flow Pipeline.

Route Development

The Study included the development and evaluation of feasible route sub-alternatives. A high-level evaluation of the route sub-alternatives was utilized to identify three route alternatives (referred to as Route Alternatives M1, M2, and

M3), as discussed during the Route Study Meeting: Water Supply Route Development (4-100 M-04) held with WWU on November 30, 2017. The three route alternatives were evaluated to identify a preferred route guided by the Envision Rating System for Sustainable Infrastructure.

For the purposes of this Study, the Water Supply Pumping Station (WSPS) and connection point to MWW's distribution system were located near the intersection of 60th Street and Howard Avenue in Milwaukee. Through discussions with MWW, the location of the WSPS was not anticipated to be a differentiating factor in determining a preferred route identified as part of this Study. Feasible route sub-alternatives were identified from east to west, beginning at the intersection of 60th Street and Howard Avenue and ending at the anticipated Booster Pumping Station (BPS) location southwest of the intersection of Racine Avenue and Swartz Road in the City of New Berlin (New Berlin). The nature of the existing right-of-way between the BPS and the connection to WWU's distribution system eliminated the need to evaluate route alternatives downstream of the BPS.

To identify route sub-alternatives, data was collected and reviewed. Field reconnaissance occurred on November 14 and 29, 2017 and surface conditions were noted. The anticipated connection to MWW's distribution system is located nearly due east of the BPS and, therefore, it was decided that the route alternatives would maintain predominantly east-west alignments and avoid additional pipeline lengths in the north-south direction to the extent feasible.

To generate a manageable number of route sub-alternatives for the evaluation, the Milwaukee Route Study Area was separated into three panels. Route sub-alternatives were identified in each panel that limited duplication of overlapping corridors and supported the development of three distinct route alternatives. Two significant north-south features were noted that the Water Supply Pipeline will be required to cross, specifically Interstate 41 and the Root River. Potential route sub-alternatives were developed to avoid east-west corridors that would require deeper trenchless construction beneath Interstate 41 and corridors that would require longer trenchless crossings at the Root River. Route sub-alternatives were developed to minimize pipeline length, public impact, easement requirements, and suspected wetland impacts, as well as avoid recently completed or planned regional transportation projects and corridors with excessive overhead electrical utilities that would cause additional constructability and corrosion challenges.

Route sub-alternatives with the same starting and ending points were evaluated on the economic and non-economic evaluation criteria listed below. Non-economic evaluation criteria include characteristics or special requirements associated with each route sub-alternative. Although not assigned a cost value, the non-economic evaluation criteria allow consideration of the factors of importance for each route sub-alternative.

- | | | |
|-------------------------------|----------------------------------|-----------------------------|
| • Sub-alternative length | • Total special crossings length | • Potential wetland impacts |
| • Traffic | • Number of easements | • Constructability |
| • Right-of-way width | • Total easements length | • Existing utilities |
| • Number of special crossings | | • Significant Features |

The findings from the economic and non-economic evaluation were reviewed with WWU as part of the Route Study – Water Supply Route Development Meeting (4-100 M-04) held on November 30, 2017. Based on the economic and non-economic evaluation, three route alternatives were selected for further evaluation as part of this Study as shown on **Figure ES-1**. These route alternatives were numbered from Route Alternative M1, representing the most northern route alternative, to Route Alternative M3, representing the most southern route alternative.

Document Path: G:\15310-Waukesha Great Lakes Water Supply PM-CM24 GIS\24.05_Working_MXD\Working_Milwaukee_New\Preferred Routes_04052018_CEW.mxd

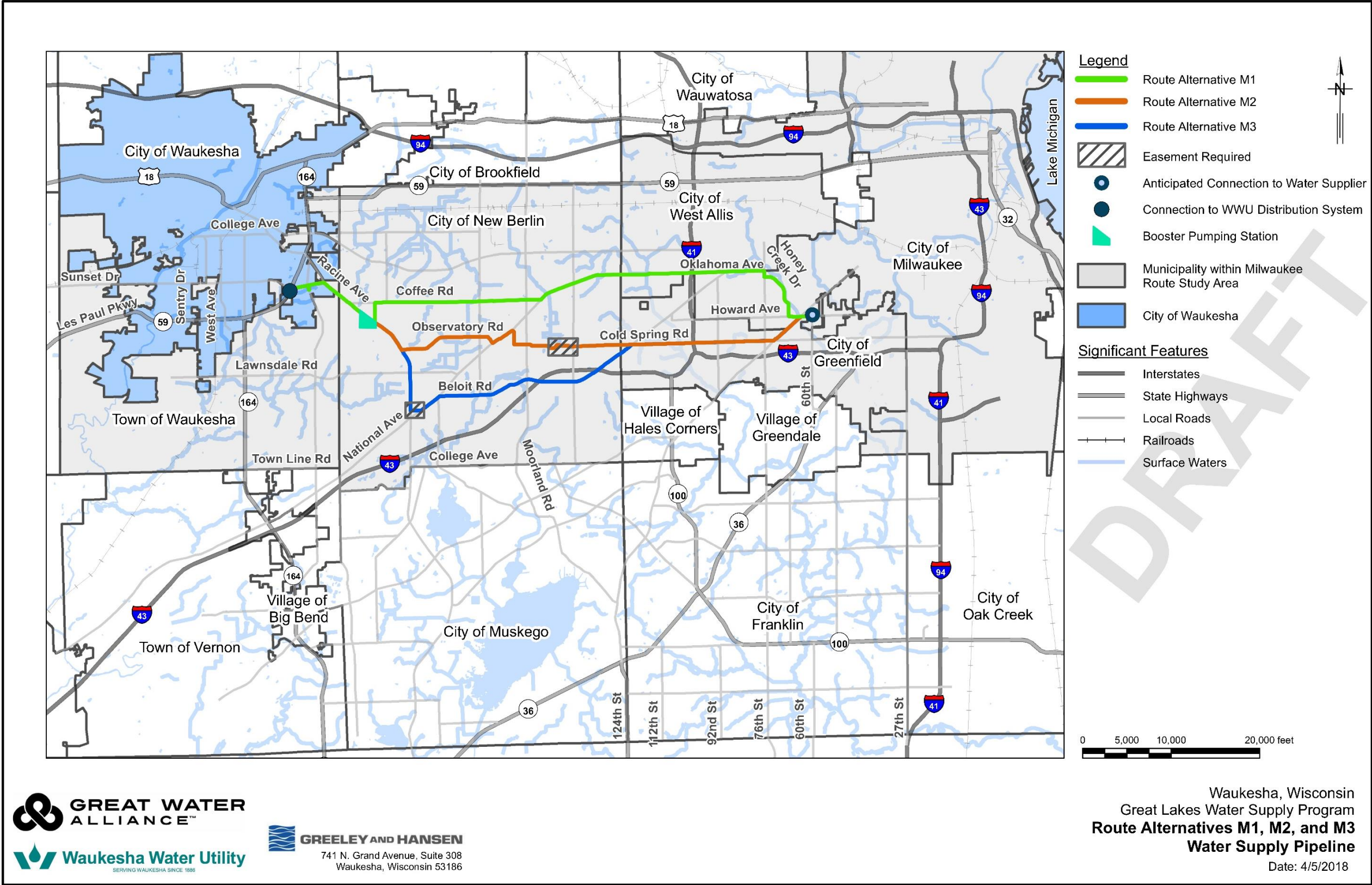


Figure ES-1 Route Alternatives M1, M2, and M3 – Water Supply Pipeline

Route Study

The following economic and non-economic evaluation criteria were used to evaluate Route Alternative M1, M2, and M3:

Non-economic Evaluation Criteria

- Total pipeline length
- Special crossings
- Geotechnical conditions
- Contaminated materials
- Wetlands
- Waterways
- Endangered resources
- Cultural resources

Economic Evaluation Criteria

- Agricultural resources
- Maintenance of traffic requirements
- Recent and planned regional transportation projects
- Stakeholder feedback
- Real property and easement requirements
- Constructability
- Class 4 opinions of probable construction cost (OPCCs)
- Life cycle pumping costs

The preliminary horizontal alignments, special crossings, and steady state hydraulics were developed utilizing the non-economic evaluation criteria above to develop the Opinions of Probable Construction Cost (OPCCs). Class 4 OPCCs were prepared in accordance with the Association for the Advancement of Cost Engineering's (AACE's) Recommended Practice No. 18R-97. A Class 4 OPCC per AACE standards is typically used for project screening, determination of feasibility, and concept evaluation. Costs were developed at an Engineering News-Record Construction Cost Indices (ENR CCI) value of 10,942 with a contingency of 25%, bonds and insurance (at 3%), mobilization and demobilization (at 5%), and contractor overhead and profit (at 15%).

Class 4 OPCCs for the Water Supply Pipeline and Appurtenances per route alternative are shown in **Table ES-1**, rounded to the nearest tenth of a million dollars. Class 4 OPCCs for Route Alternatives M1 and M2 are also shown in **Table ES-1** relative to that of Route Alternative M3, as previous planning efforts for the Program have considered a route similar to Route Alternative M3.

Table ES-1 Class 4 Opinions of Probable Construction Cost for Route Alternatives

Item	Class 4 OPCCs for Route Alternatives (June 2017 ENR CCI = 10,942)		
	M1	M2	M3
Class 4 OPCCs ¹ (\$-Million)	63.2	64.6	69.5
Class 4 OPCC Comparison (\$-Million)	-6.3	-4.9	0.0

Notes: 1. Class OPCCs include Water Supply Pipeline and Appurtenances only.

As shown in **Table ES-1**, the Class 4 OPCC for Route Alternative M1 is less than the Class 4 OPCCs for Route Alternatives M2 and M3.

Economic and non-economic evaluation criteria were used to develop route scoring to identify a preferred route. The evaluation process was guided by the Envision Rating System for Sustainable Infrastructure. Key Performance Indicators (KPIs) were identified to integrate WWU's values into the design process and provide a basis for developing metrics to evaluate and compare route alternatives. KPIs are criteria that remain constant with constant weights, but the alternatives and the metrics for each KPI change based on the decision that is being evaluated. Although they are not all assigned a cost value, the KPIs are of critical importance in determining the preferred route. The KPI definitions were developed to be broad enough to apply to all aspects of the Program and act as universal weighing criteria. WWU staff weighed the KPIs from one (to represent a less significant or lower perceived impact to

the Program and public) to ten (to represent a more significant or higher perceived impact to the Program and public). The weights were linearly scaled such that the sum of all weights produced a value of 100.

The KPIs are listed by descending weights in **Table ES-2** alongside their definitions which are aligned with the sustainability guidelines from the Envision Rating System for Sustainable Infrastructure.

Table ES-2 Key Performance Indicator Summary

Key Performance Indicator	Definition	Weight
System Reliability	Using robust design strategies, preventive maintenance and intuitive configurations, Program Elements are dependable and resilient.	19
Life Cycle Cost	Pursue strategies that reduce long-term operational and maintenance costs.	15.5
Schedule	Complete the Program in a timeframe that mitigates negative impacts on the affected communities' quality of life.	14
Ease of Construction	Avoid sites that require intensive efforts to preserve or restore existing environmental conditions and utilities, integrate infrastructure, or access with construction equipment.	11
Public Acceptability	The Program vision and goals align with those of the affected communities, and the implementation of the Program expands the skills, capacity, mobility, and health of a community while mitigating negative impacts.	6.5
Capital Cost	Minimize financial impact on the affected communities with consideration of factors such as resource conservation, ease of infrastructure integration, and avoiding site development that requires additional efforts to preserve existing site conditions.	6
Effects on Ability to Finance	Through triple bottom line (TBL) analysis of social, economic, and environmental impacts, Program Elements have been mitigated for risk and resiliency, helping enhance support for infrastructure investment.	6
Future Expansion	Implement designs and other measures that allow for the expansion of the Program to incorporate Compact Council approved future connections and increased flow without requiring additional infrastructure and capital expenditure.	6
Operational Flexibility	Reduce vulnerabilities by creating an adaptable design that can function in a variety of social, economic, and environmental conditions with monitored systems that allow ease and consistency of operation.	6
Environmental Impact	Measures are taken to preserve the natural world through avoidance, monitoring, restoration, and negative impact mitigation; resources are conserved during the construction and operation of the Program; there is a concerted effort to preserve the ambient conditions that affect quality of life of the affected communities, such as noise, light, air quality, wetlands, and waterways.	5
Cost Sharing Potential	Thorough infrastructure integration and commitment to synergistic opportunities, the cost of Program Elements is potentially shared by a broader community.	5

Data and information from the economic and non-economic evaluation were used to develop metrics for the KPIs. The route alternatives were scored on a scale from one (to represent a less favorable alternative for the established KPI) to five (to represent a more favorable alternative for the established KPI) based on the performance for each metric. The scores were inserted into a Triple Bottom Line (TBL) evaluation matrix shown in **Table ES-3**. The TBL evaluation incorporates three dimensions of performance – Social and Community, Economic, and Environmental. The KPIs were assigned to the dimensions of performance to which they best correspond. The scores of each of the route alternatives in the TBL evaluation are displayed at the bottom of the matrix in which a higher score indicates a more preferable route alternative.

Economic and non-economic evaluation criteria and route scores were reviewed in the Route Study Meeting: Preliminary Preferred Water Supply Route (4-100 M-05) held with WWU on February 16, 2018 and the Route Study Meeting: Preferred Water Supply Route (4-100 M-06) held with WWU on April 6, 2018. Considering economic and

non-economic impacts to the Program and the public, Route Alternative M1 is the preferred route to supply Waukesha with a new, sustainable water supply from a water supply connection to the MWW distribution system in Milwaukee. Route Alternative M1 scored higher in most categories, especially in Public Acceptability.

Table ES-3 Triple Bottom Line Evaluation

Criteria	Weighting	Maximum Possible Score	Route Alternative		
			M1	M2	M3
1 Social and Community Goals					
1.1 Schedule	14.0	5	3	2	2
1.2 Public Acceptability	6.5	5	5	2	3
1.3 Operational Flexibility	6.0	5	3	3	3
1.4 Future Expansion	6.0	5	3	3	4
2 Economic Goals					
2.1 System Reliability	19.0	5	3	3	3
2.2 Life Cycle Cost	15.5	5	3	3	2
2.3 Ease of Construction	11.0	5	4	2	3
2.4 Capital Cost	6.0	5	3	3	2
2.5 Effects on Ability to Finance	6.0	5	4	2	3
2.6 Cost Sharing Potential	5.0	5	3	3	4
3 Environmental Goals					
3.1 Environmental Impact	5.0	5	3	3	3
Net TBL Score¹	100	500	330	263	276
Percent of Max Possible Score			66%	53%	55%

¹ Net TBL Score = Sum of sub-criteria score x Weighting for each Alternative. Net TBL Scores were rounded to nearest whole number.

As of the date of this Study, the WSPS is anticipated to be located on the southwest quadrant of 68th Street and Morgan Avenue, while the connection point to the MWW distribution system is anticipated to be located near the intersection of 60th Street and Morgan Avenue. These locations shorten Route Alternative M1 by 2,400 feet and reduce its Class 4 OPCC by approximately \$1.9M. Likewise, these locations lengthen Route Alternatives M2 and M3 by 3,700 feet, while increasing their Class 4 OPCCs by \$2.5M. The anticipated locations have not changed the preferred route identified in this Study, and only serve to make the preferred route, Route Alternative M1, even more preferable than the other route alternatives.

The preferred route, Route Alternative M1 as shown on **Figure ES-2**, is for a connection point to the MWW distribution system at 60th Street and Morgan Avenue and the WSPS at 68th Street and Morgan Avenue. The Water Supply Pipeline with this configuration will also be reflected in the Draft Preliminary Design Report (PDR) (6-240 D1).

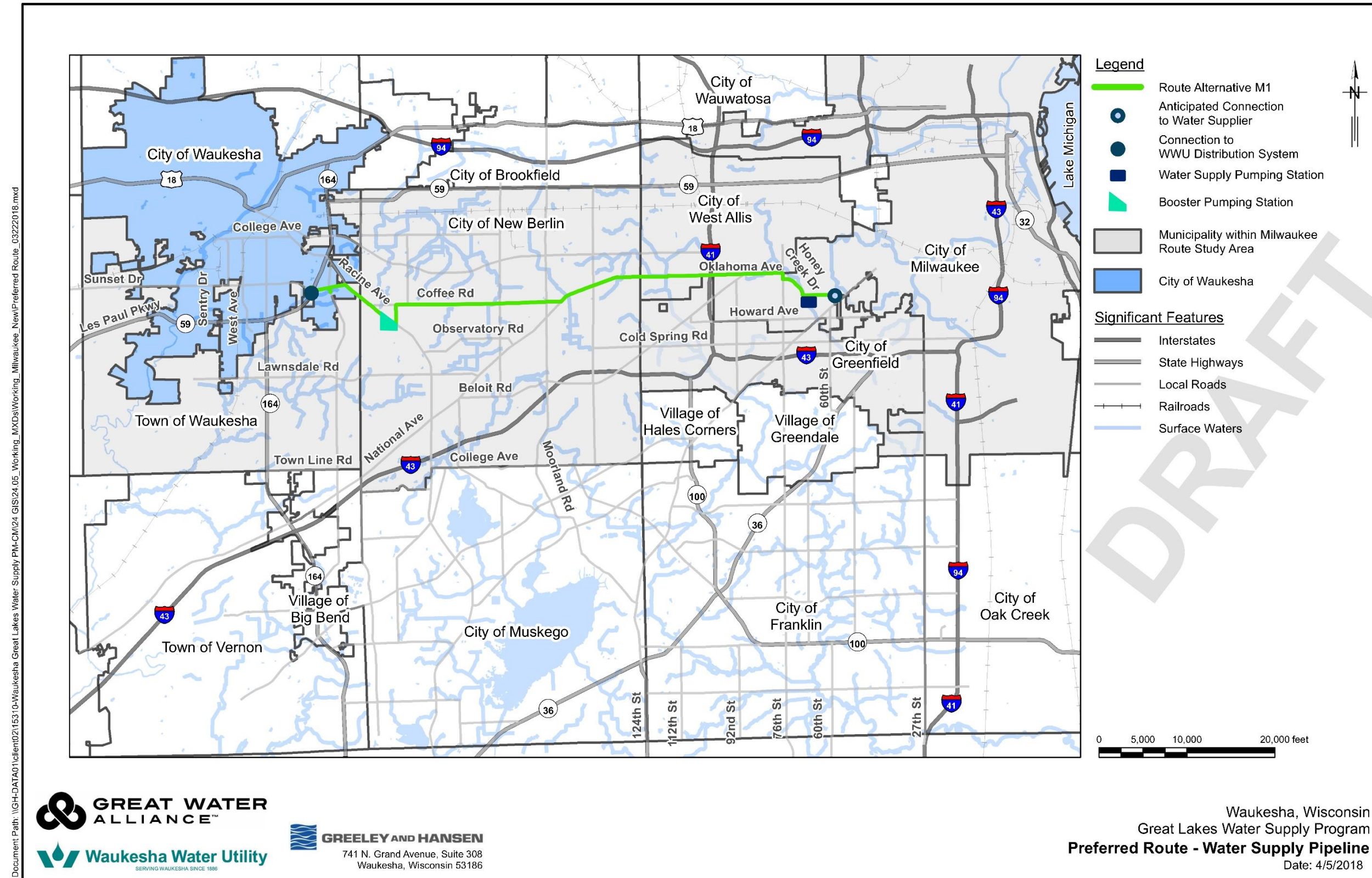


Figure ES-2 Preferred Route – Water Supply Pipeline

SECTION 1 Introduction

1.1 Background and Purpose

The Waukesha Water Utility (WWU) provides water treatment and distribution services to the City of Waukesha (Waukesha). The St. Peter Sandstone aquifer, which has been the primary source of drinking water for not only Waukesha, but for communities throughout the Midwest, is being depleted in Southeast Wisconsin. This is due in large part to a natural layer of shale rock that restricts groundwater recharge. Depletion of the St. Peter Sandstone aquifer has also caused increases in the concentrations of radium and other contaminants. As a result, Waukesha needs a long-term, sustainable alternative to its existing water supply to protect public health.

WWU owns and operates a system of wells that pump groundwater for treatment and to WWU's distribution system. In 2009, the Department of Justice (DOJ) issued a Stipulation Order to WWU to enforce state drinking water radionuclide standards. In October 2013, following study efforts and public engagement, Waukesha resubmitted its Application for Lake Michigan Diversion with Return Flow (Application) to the Wisconsin Department of Natural Resources (WDNR). In the Application, Lake Michigan water was determined to be the only reasonable, sustainable source of water that protects both the environment and public health. WDNR concurred that Waukesha's Application met the criteria of the Great Lakes-St. Lawrence River Basin Water Resources Compact (Compact) and submitted the Application to the Great Lakes-St. Lawrence River Basin Water Resources Council (Compact Council) for review.

The Compact Council was established in 2008 when the Compact became federal and state law in the United States. The Compact Council is comprised of eight governors from the Great Lakes states: Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin. The purpose of the Compact is to provide a legal mechanism to manage and protect the Great Lakes-St. Lawrence River Basin per the governors' pledge with the premiers of Ontario and Quebec as part of the Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement.

In its Final Decision, dated June 21, 2016, the Compact Council unanimously approved Waukesha's Application to source water from Lake Michigan. WWU subsequently commissioned a team of consultants to implement the Great Water Alliance (Program) to transition Waukesha's water supply from groundwater to Lake Michigan water. The purpose of the Program is to plan, design, construct, and commission infrastructure with a 100-year useful life necessary to transition Waukesha's water supply from groundwater to surface water. The Program is the first for a community in a county that straddles the Great Lakes-St. Lawrence River Basin to access Great Lakes water through the Compact. Successful implementation of the Program will set industry precedents for solving water quality and water scarcity challenges for at-risk water supplies in other Great Lakes communities.

Approximately 23 miles of main (referred to as the "Return Flow Pipeline") with pumping facilities located at Waukesha's Clean Water Plant (CWP) are required per the Final Decision to achieve a net zero water balance in the Great Lakes-St. Lawrence River Basin by discharging highly treated effluent to the Root River, which ultimately discharges into Lake Michigan.

Per an Amended Stipulation Order in July 2017, Waukesha's water supply transition needs to be completed by September 1, 2023. If the Program construction is not at 50% completion as of May 1, 2022, bidding and construction of interim radium treatment for Waukesha's current water source will be required in order to meet the Radionuclide Standards as set by the United States Environmental Protection Agency.

Thirteen key Program Elements associated with the construction of Program infrastructure were identified as follows. These Program Elements were presented as part of the Phase 1 High-Level Cost Validation Workshop (Phase 1, W-05) held with WWU on November 10, 2016. The Program Elements were also provided as part of the High-Level Program Cost Evaluation Memorandum.

1. Water Connection at Water Supplier
2. Water Supply Pumping Station (WSPS)
3. Water Supply Pipeline and Appurtenances
4. Water Reservoirs
5. Booster Pumping Station (BPS)
6. Chemical Feed Facilities
7. Water Connection to Waukesha
8. WWU Distribution System Improvements
9. Return Flow Pumping Station (RFPS)
10. Return Flow Pipeline and Appurtenances
11. Return Flow Discharge Facilities at Root River
12. Necessary CWP Improvements (Exclusive of RFPS)
13. Other Program Elements

The water supply system will require piping and facilities capable of delivering flow from the City of Milwaukee (Milwaukee) to Waukesha. As a result, the water supply system was evaluated with the following key infrastructure, as depicted in **Figure 1-1**.

- **Water Supply Pumping Station (WSPS):** A WSPS to provide the head to convey flow towards Waukesha.
- **Water Supply Pipeline:** A Water Supply Pipeline to convey flow from the WSPS to the Water Supply Pipeline's connection to WWU's distribution system.
- **Water Reservoirs:** A means for storage between the WSPS and the Water Supply Pipeline's connection to WWU's distribution system to attenuate demands and provide for emergency storage. An air break will be used to protect WWU's distribution system from hydraulic transients in the Water Supply Pipeline and WSPS.
- **Booster Pumping Station (BPS):** A BPS to provide the head necessary to convey flow from the water reservoirs to WWU's distribution system.
- **Water Supply Control Building (WSCB):** A WSCB will house pressure reducing valves (PRVs) to reduce Water Supply Pipeline pressures to within a desirable range for WWU's distribution system.
- **Connection to WWU's Distribution System:** The Water Supply Pipeline connection to WWU's distribution system to supply Waukesha with Lake Michigan water.

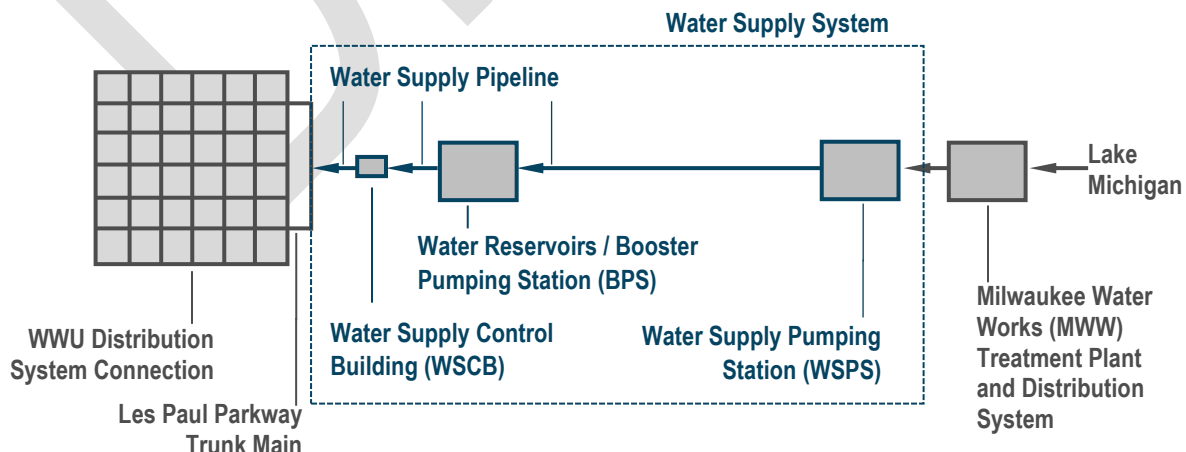


Figure 1-1 Water Supply System Diagram

1.2 Route Study: Oak Creek

A Draft Route Study: Oak Creek (4-100 D1) was submitted to WWU in October 2017 to identify a preferred route that would be used to supply Waukesha with a new, sustainable water supply from a water supply connection to the City of Oak Creek through the Water Supply Pipeline, and return highly treated effluent to the Root River through the Return Flow Pipeline. The Draft Route Study: Milwaukee (4-100 D2) was initiated for the Water Supply Pipeline between Milwaukee and Waukesha due to a change in the anticipated water supplier. The preferred route for the Return Flow Pipeline identified in the Draft Route Study: Oak Creek (4-100 D1) remains unchanged.

1.3 Scope of Services

This Draft Route Study: Milwaukee (4-100 D2) summarizes the work conducted under Task 4-100 of the Program. The purpose of this Route Study (Study) is to identify the preferred route for the Water Supply Pipeline that will be used to supply Waukesha with a new, sustainable water supply from a water supply connection with Milwaukee Water Works (MWW). Specific tasks consisted of collecting and reviewing pertinent data, field reconnaissance, performing desktop assessments, conducting public Open House Meetings and incorporating stakeholder feedback, completing steady state hydraulic analyses, and preparing Class 4 opinions of probable construction cost (OPCCs) in order to complete the evaluation and select a preferred route.

The route alternatives have been evaluated with respect to the following economic and non-economic evaluation criteria developed with input from WWU that are summarized as follows in the order they are presented in this Study:

Non-economic Evaluation Criteria

- Total pipeline length
- Special crossings
- Geotechnical conditions
- Contaminated materials
- Wetlands
- Waterways
- Endangered resources
- Cultural resources

Economic Evaluation Criteria

- Agricultural resources
- Maintenance of traffic requirements
- Recent and planned regional transportation projects
- Stakeholder feedback
- Real property and easement requirements
- Constructability
- Class 4 opinions of probable construction cost (OPCCs)
- Life cycle pumping costs

The economic and non-economic evaluation criteria were used to identify a preferred route. Route alternatives were scored based on the economic and non-economic evaluation. Route scoring was guided by the Envision Rating System for Sustainable Infrastructure. The Envision Rating System evaluates, scores, and gives recognition to infrastructure projects that make exemplary progress and contribute to the long-term sustainability of the communities served. The holistic and sustainable approach to decision making that Envision provides continues to aid the Program in the creation of a robust and resilient design.

SECTION 2 Data Collection

The following section summarizes data collection methods used for this Study, as well as information for the Milwaukee Route Study Area and known or potential connection points for the Water Supply Pipeline.

2.1 Data Sources

The data gathered and reviewed as part of this Study included Geographic Information Systems (GIS) database files, aerial photography, documents, contract documents/diagrams, geotechnical database files, and hazardous waste or contaminated site database files. Utility information and property lines were obtained as GIS files from WWU, Milwaukee County, Waukesha County, and other nearby municipalities. The datum for GIS database files throughout the Program is the North American Datum 1927 (NAD 27). Utility coordination will continue in design with entities that own infrastructure in proximity to the proposed alignment. **Table 2-1** shows a summary of the information gathered.

Table 2-1 Data Review Summary

Data	Source	Description
GIS Database Files	City of Milwaukee	Tax parcels and right-of-way lines
	City of New Berlin	Tax parcels and right-of-way lines
	City of Greenfield	Tax parcels and right-of-way lines
	Milwaukee County	Public / private water map, public land holdings, tax parcels, right-of-way lines, railroads, parks, municipal boundaries, and topographic contours
	City of Waukesha	Water, storm, sanitary
	Waukesha County	Public / private water map, storm, sewer service areas, county highway pavement conditions, average daily traffic, soils, trails, buildings, rail, parcels, municipal boundaries, and topographic contours
	City of West Allis	Tax parcels and right-of-way lines
Aerial Photography	Program	Aerial photography (photographed in Fall 2016 and Fall 2017), wetlands, floodplain/floodway, water bodies, and digital elevation model
Documents	Other	Pipe catalogues and data from comparable project experience
	RS Means	RS Means data
	City of Waukesha	Bid tabs, budget, audited financial statements, PSC annual reports and housing statistics
		Waukesha Return Flow Plan
		Waukesha Supply Service Area Plan
Contract Drawings / Diagrams	WisDOT	Bid tabs
	City of Milwaukee	South 60th Street roadway project
	City of Waukesha	Les Paul Water Main Project – Phase 2 Bid Set
		January 2, 2015 Wastewater Treatment Plant Improvements, Phase II
Geotechnical, Wetland, Waterway, and Protected Resources Database Files	MMSD	Soil boring logs
	NRCS	Soils, groundwater, wetlands
	SEWRPC	Bedrock, groundwater
	USDA	NRCS – SURGO Database – Web soil survey data
	USGS	Wetlands, waterways
	WDNR	Well Construction Reports, Wetland Indicator Soils Data, DWI, NHI database
	WHPD	ARI, ASI, and AHI
Hazardous Waste / Contaminated Site	WisDOT	Highway Structures Information System
	ERIS	Contaminated sites identification
	WDNR	Superfund sites, groundwater and soil contamination sites, dry clean environmental sites, and open and closed sites

Notes:

- AHI = Architecture and History Inventory; ARI = Archaeological Report Inventory; ASI = Archaeological Sites Inventory; DWI = Digital Wetland Inventory; ERIS = Environmental Risk Information Services; MMSD = Milwaukee Metropolitan Sewerage District; NHI = National Heritage Inventory; NRCS = National Resource Conservation Service; PSC = Public Service Commission; SEWRPC = Southeastern Wisconsin Regional Planning Commission; SSURGO = Soil Survey Geographic Database; USDA = United States Department of Agriculture; USGS = United States Geological Survey; WDNR = Wisconsin Department of Natural Resources; WisDOT = Wisconsin Department of Transportation

2.2 Milwaukee Route Study Area

Figure 2-1 presents the Milwaukee Route Study Area outlined in blue with communities overlapped by the Milwaukee Route Study Area with the potential for route alternatives shaded grey. The Milwaukee Route Study Area is generally bounded to include 60th Street on the east, Interstate 43 east of Racine Avenue on the south, Oklahoma Avenue on the north, and Sunset Drive east of Les Paul Parkway on the west.

The Milwaukee Route Study Area was discussed during the Route Study Meeting: Water Supply Route Development (4-100 M-04) held with WWU on November 30, 2017. Refer to **Appendix J** for the workshop and meeting summaries.

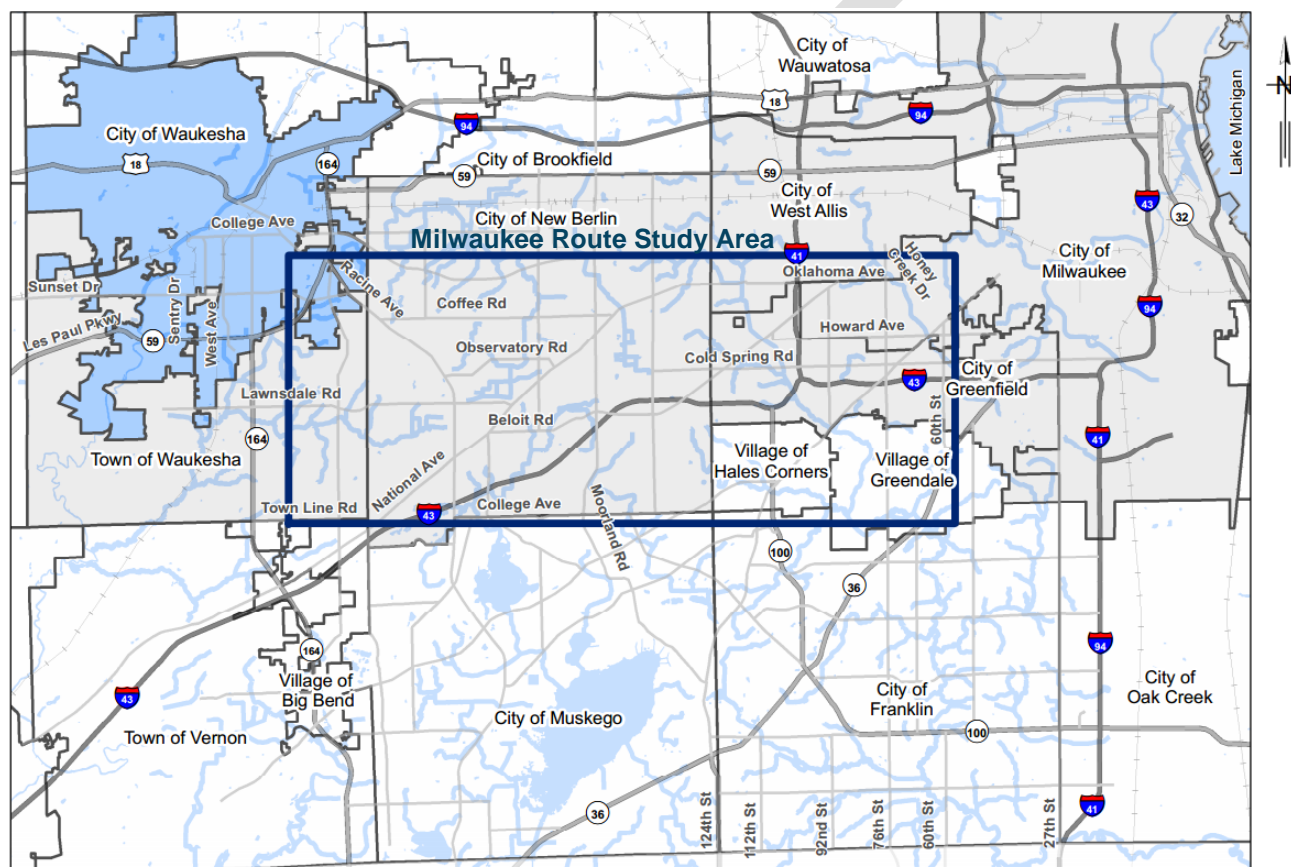


Figure 2-1 Milwaukee Route Study Area

2.3 Points of Connection

Known or potential starting and ending points of connection for the Water Supply Pipeline were discussed in the Route Study Meeting: Water Supply Route Development (4-100 M-04) held with WWU on November 30, 2017 and are described in the following sections. Each connection point provides boundary conditions for the Milwaukee Route Study Area and serves as the starting and ending points of each route alternative.

2.3.1 Water Supply Pipeline Connection to Water Supplier

From discussions with representatives from MWW, it was determined that the anticipated point of connection to the MWW distribution system would be located at 60th Street and Howard Avenue, and that a new WSPS would be located in proximity to the anticipated point of connection. The Water Supply Pipeline would be supplied from an existing 54-inch trunk main that runs beneath 60th Street. In this configuration, the WSPS would also serve as the Water Supply Pipeline's starting point.

The anticipated point of connection to the MWW distribution system is shown on **Figure 2-2** overlaid on aerial photography taken in Fall 2017.

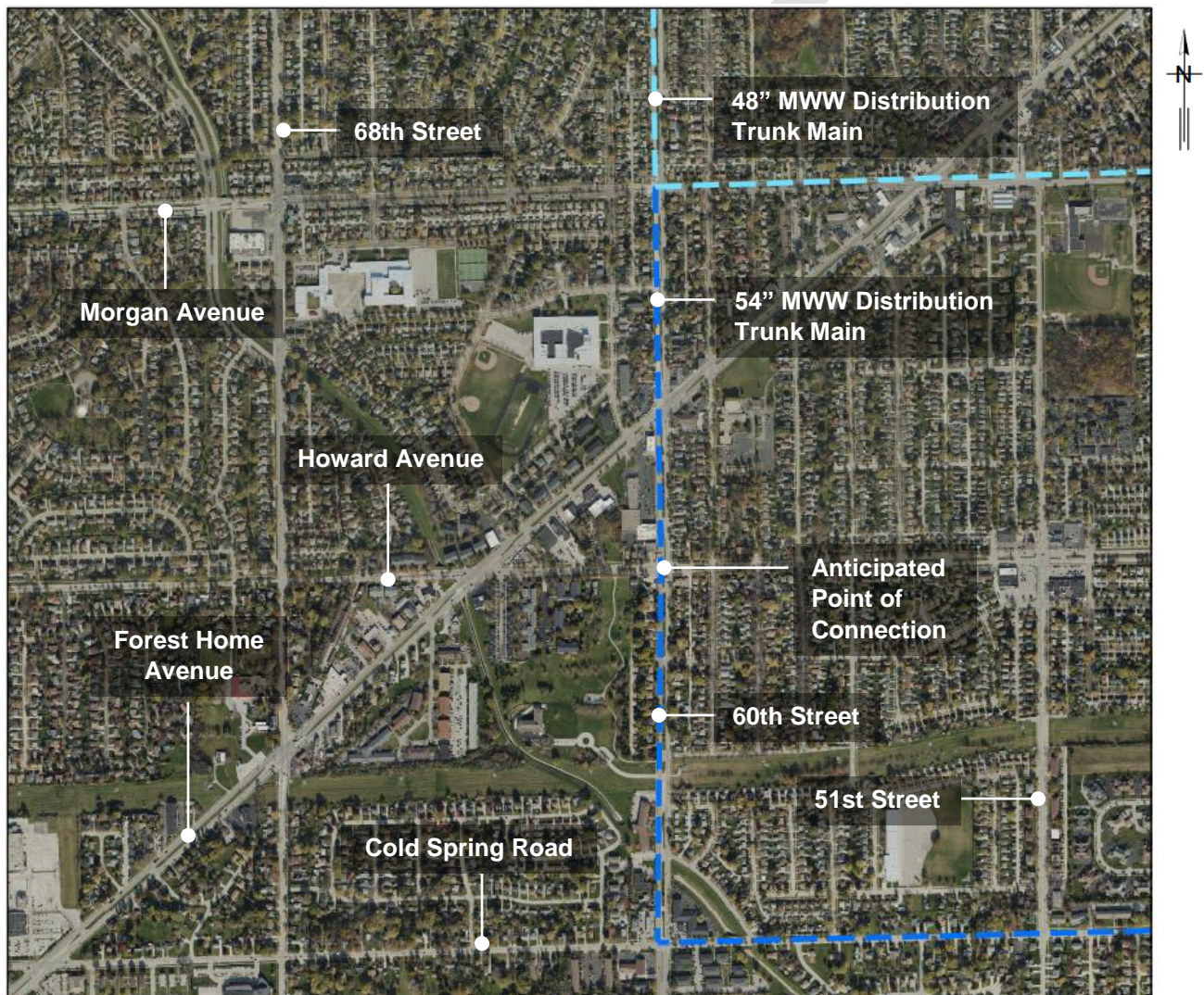


Figure 2-2 Anticipated Point of Connection to Water Supplier

For the purposes of this Study, the location of the WSPS and point of connection to the MWW distribution system is the intersection of 60th Street and Howard Avenue.

2.3.2 Water Supply Pipeline Connection to Reservoir and Booster Pumping Station

The Water Supply Pipeline will connect to new water reservoirs upstream of its connection to WWU's distribution system. The water reservoirs will be utilized to attenuate demands and provide for storage. A new BPS will be required to provide the head necessary to convey flow from the water reservoirs to WWU's distribution system. Site screening was performed for potential locations for the water reservoirs and BPS, as discussed with WWU during the BPS Site and Building Meeting (6-200 M-01) held on June 29, 2017. It was determined the water reservoirs and BPS would be located in Minooka Park, southwest of the intersection of Racine Avenue and Swartz Road in the City of New Berlin (New Berlin) on Parcel NBC 1224994 owned by the Waukesha County Department of Parks and Land Use. Refer to the Draft Preliminary Design Report (PDR) (6-240 D1) for details on this evaluation.

Parcel NBC 1224994 is shown on **Figure 2-3** and overlaid on aerial photography taken in Fall 2016. The property will serve as the location for the water reservoirs and BPS. For the purposes of this Study, the Water Supply Pipeline will discharge into the water reservoirs on Parcel NBC 1224994 upstream of the connection to WWU's distribution system.



Figure 2-3 Water Reservoirs and Booster Pumping Station Location

2.3.3 Water Supply Pipeline Connection to Waukesha Water Utility Distribution System

Downstream of the water reservoirs and BPS, the Water Supply Pipeline will connect to WWU's distribution system along Les Paul Parkway at a 24-inch trunk main. Distribution system modeling was performed as part of the Program to evaluate the preferred Water Supply Pipeline connection point to WWU's distribution system routed from the BPS located on Parcel NBC 1224994. The evaluation included four alternative connection points. The alternatives were evaluated based on distribution system improvements required to accommodate each connection point, available land to locate the WSCB, and cost. The potential connection points were discussed with WWU during the Distribution System Hydraulic Model Meeting (5-100 M-05) held on October 13, 2017 and it was determined that the connection point at Les Paul Parkway and Sunset Drive is preferred. The connection point was selected due to its proximity to Parcel WAKC 1349999 owned by WWU that could be used to locate the new WSCB. The WSCB will house PRVs that will serve to reduce pressures to within a desirable range for WWU's distribution system. Refer to the PDR for details of this evaluation.

The connection location is shown on **Figure 2-4** and overlaid upon aerial photography taken in Fall 2016. For the purposes of this Study, the Water Supply Pipeline will end at the connection to WWU's distribution system at the intersection of Les Paul Parkway and Sunset Drive.



Figure 2-4 Waukesha Water Utility Distribution System Connection

2.4 Property and Right-of-Way Information

Waukesha and Milwaukee GIS database files have been used to provide right-of-way and property information for this Study. Assessor documentation will be acquired to confirm property boundaries and define real property interests (i.e., ownership) during design.

Public utilities utilize right-of-way to reduce easement requirements and provided ease of access for maintenance. As such, the route alternatives developed as part of this Study predominantly utilize right-of-way maintained by the City of Greenfield (Greenfield), Milwaukee, New Berlin, the Town of Waukesha, Waukesha, and the City of West Allis (West Allis). In areas in which construction of the pipelines within right-of-way is impractical, the route alternatives depart right-of-way and traverse private property across several segments. Refer to **Section 5.1.13** for a summary of the relevant right-of-way ownership and easement requirements.

2.5 Recent and Planned Regional Transportation Projects

Regional transportation projects and improvements are planned by state and local agencies in the Milwaukee Route Study Area. Information about these projects was obtained from capital improvement plans, meetings with local municipalities, and county and state Departments of Transportation (DOTs). Where impacts and activity schedules overlap, the Water Supply Pipeline will be adjusted to minimize or avoid conflicts and take advantage of potential synergies, such as sharing maintenance of traffic and surface restoration costs for the given project and the Program.

A summary of a recently completed regional transportation project identified within the Milwaukee Route Study Area coinciding with the route alternatives is shown in **Table 2-2**. Recently completed regional transportation projects have been defined as those that were completed in 2017. No planned regional transportation projects have been identified parallel to the route alternatives. Recently completed or planned regional transportation projects will continue to be monitored and identified in coordination with local municipalities throughout design.

Table 2-2 Recently Completed and Planned Regional Transportation Projects Summary

Project Description	Agency	Start Year	Project No.	Start	End
Beloit Avenue Reconditioning	City of New Berlin	2017	2790-00-00	Moorland Road	National Avenue

2.6 Typical Cross Sections

Trench depth as well as depth and materials of pipe bedding and cover of the pipelines were developed from review of applicable municipal and state regulations, previous project experience in Southeast Wisconsin, industry standards from American Water Works Association (AWWA), and manufacturers. Typical cross sections (or, typical sections) were developed to meet the regulations and standards for trench depth, bedding, and cover for varying sizes of pipe that will be evaluated later in this Study. Typical sections were used to evaluate if right-of-way width and space constrained areas could accommodate the Water Supply Pipeline for the potential pipe diameters.

The typical single pipe sections under pavement and landscape areas shown on **Figure 2-5** demonstrate surface restoration under an existing road with nine inches of concrete pavement and six inches of aggregate base. These thicknesses are typical and will be adjusted during design in accordance with each road's individual existing condition per the local municipality's pavement standards (refer to **Table 2-3** for a summary of the key local municipal design standards). The typical section under landscape on **Figure 2-5** demonstrates surface restoration with six inches of topsoil and a layer of seed. Each landscaped area will be restored in accordance with each existing condition.

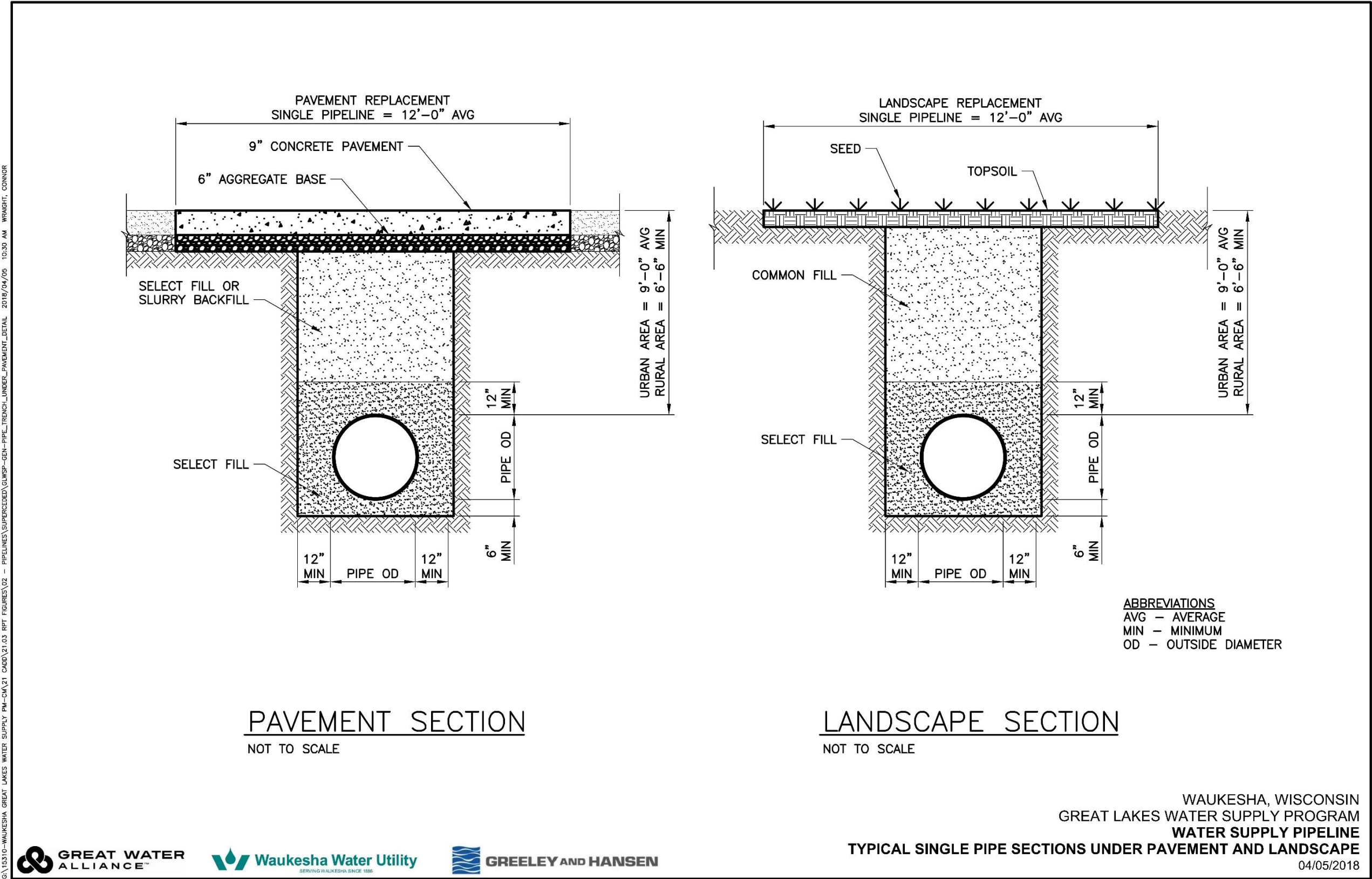


Figure 2-5 Typical Single Pipe Sections under Pavement and Landscape

Table 2-3 Municipal Pavement Design Standards

Item	Municipality ²					
	City of Milwaukee	City of Greenfield	City of New Berlin	City of Waukesha	Town of Waukesha	City of West Allis
Asphalt Pavement						
Base Course Thickness (inch)	8.0	8.0	Local Roads: 8.0 Industrial Roads: 14.5	Note 1	10.0	8.0
Binder Course Thickness (inch)	4.5	3.0	Local Roads: 3.0 Commercial Roads: 4.0	3.5 maximum	Note 1	1.5
Surface Course Thickness (inch)	1.5	2.0	Local Roads: 2.0 Commercial Roads: 2.0	Note 1	1.5	1.5
Cross Slope (%)	2.0	2.0	3.0	Note 1	Note 1	Note 1
Base Course Material	Note 1	Crushed Limestone	Crushed Limestone	Crushed Limestone, Gravel or Sand	Traffic Bond	Note 1
Tack Coat Rate (gallon/square yard)	Note 1	Note 1	0.05	0.05 - 0.15	Note 1	0.10
Concrete Pavement						
Pavement Thickness (inch)	7.0	7.0	Note 1	Note 1	Note 1	Note 1
Base Course Thickness (inch)	6.0	8.0	Note 1	6.0	Note 1	8.0
Cross Slope (%)	2.0	2.0	Note 1	Note 1	Note 1	Note 1
Concrete Grade	Note 1	Note 1	Note 1	AA	Note 1	Note 1

Notes:

1. This municipality does not have a design standard for this item.
2. Typical pavement sections on **Figure 2-5** and **Figure 2-6** assumes the average design standard for municipalities traversed by the route alternatives is nine inches of concrete pavement and six inches of aggregate base.

There are segments of the Water Supply Pipeline that will exist in corridors that will also contain the Return Flow Pipeline. Corridors containing both the Water Supply and Return Flow Pipelines are called the Common Corridor. The minimum horizontal distance between the Water Supply and Return Flow Pipelines in the Common Corridor is stipulated in the Wisconsin Administrative Code NR 811.74. Standards and regulations for municipalities in which the Common Corridor traverses were also reviewed. Local municipal standards for horizontal separation between water and sewer mains either designate an eight-foot horizontal separation distance or refer to the governing Wisconsin Administrative Code, NR 811.74. The NR 811.74 Administrative Code states water mains shall be laid at least eight feet horizontally, center-to-center, from any existing or proposed sanitary sewer main, storm sewer main, or sanitary or storm sewer manhole. Thus, an eight-foot center-to-center horizontal separation has been used in developing typical sections and preliminary horizontal alignments in the Common Corridor between the Water Supply and Return Flow Pipelines as shown on **Figure 2-6** and **Figure 2-7**. The typical sections were reviewed with WDNR during the Pipeline Horizontal Separation Meeting (4-300 M-03) held on October 17, 2017. WDNR confirmed the typical sections are acceptable.

WDNR regulations and local municipality specifications were reviewed to determine proper depth of trench for the Water Supply and Return Flow Pipelines. Per Wisconsin Administrative Code NR 811.73 (2) (b), the depth of the excavated trench is required to be at least six inches below the bottom of the pipe. WWU Specifications for Water Main, Chapter 6, Section 6.1.2 states that the depth of the excavated trench shall be at least six inches, but no more than 12 inches below the bottom of the pipe. Other municipalities in the Milwaukee Route Study Area either do not have specific language regarding excavation depth or refer to WDNR regulations. The trench depth of the typical sections as shown on **Figure 2-5** through **Figure 2-7** satisfy the applicable regulations. The requirements are set forth regardless of pipe material.

WDNR regulations and local municipal specifications were reviewed to determine proper pipe cover for both the Water Supply and Return Flow Pipelines. Per Wisconsin Administrative Code NR 811.73 (2) (e), sufficient earth or suitable material is required to have a minimum cover of five to seven feet in order to prevent freezing. WWU Specifications for Water Main require a minimum cover of six feet and a maximum cover of seven feet. The City of New Berlin requires a minimum cover of five feet. Other municipalities within the Milwaukee Route Study Area either do not have specific language or refer to WDNR regulations. A minimum depth of cover of 6.5 feet has been utilized for this Study. The pipe cover of the typical sections as shown on **Figure 2-5** through **Figure 2-7** satisfy the applicable regulations.

Although WWU Specifications for Water Main indicates a maximum cover of seven feet, the pipelines will require a greater depth of cover at certain utility crossings, special crossings, and where other circumstances require. The majority of these situations are anticipated to occur in urban areas. For the purposes of this Study, an average depth of cover of nine feet has been utilized to approximate the average depth that will result in urban areas. From AWWA standards and discussions with pipe manufacturers, this depth of cover does not require additional consideration for pipe wall thickness.

WDNR regulations and local municipality specifications were reviewed to determine the proper depth of pipe bedding required on top of the pipe trench. WWU Specifications for Water Main require that after the pipe is laid, bedding is to be deposited around the pipe up to at least one foot above the top of pipe. Other municipalities within the Milwaukee Route Study Area do not have specific language regarding pipe bedding on top of pipe. The depth of pipe bedding on top of the pipe as shown on **Figure 2-5** through **Figure 2-7** satisfy the applicable standards.

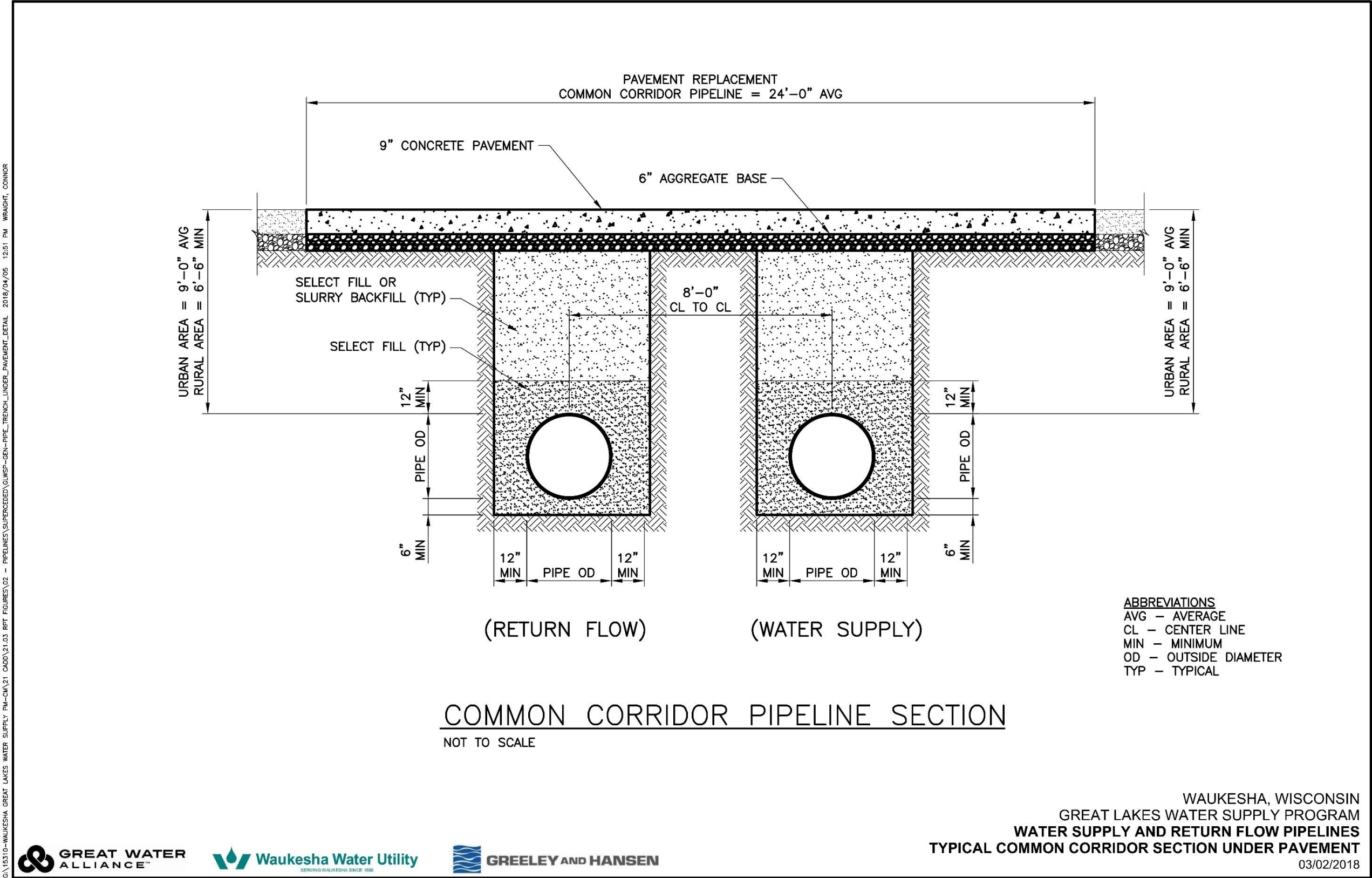


Figure 2-6 Typical Common Corridor Section under Pavement

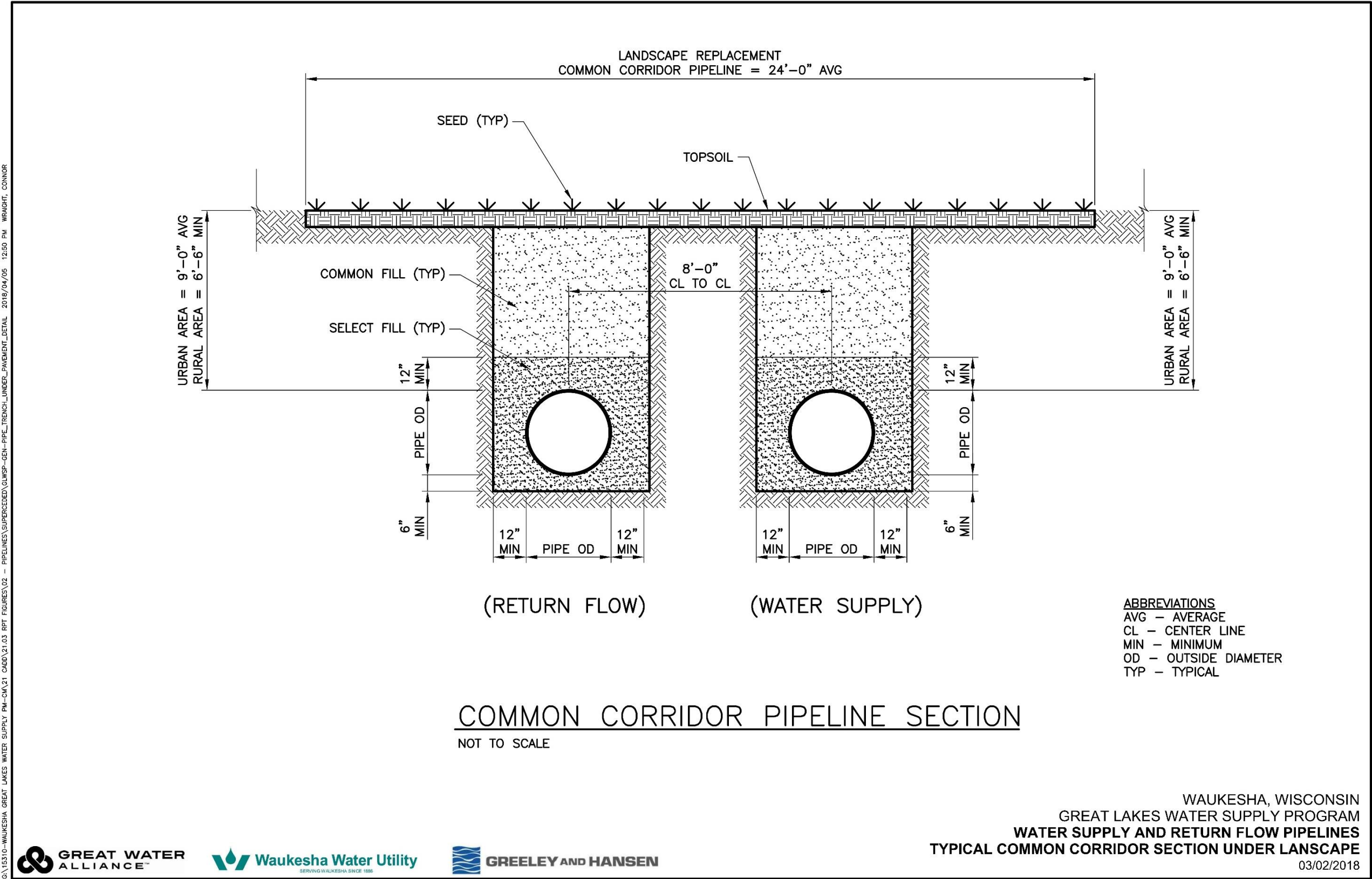


Figure 2-7 Typical Common Corridor Section under Landscape

2.7 Special Crossings

In instances where the Water Supply Pipeline will cross a waterway, major road, or railroad, a special crossing will be required. Preliminary horizontal alignments have been developed as part of this Study using special crossing design standards and previous construction experience in Southeast Wisconsin.

Local municipality design standards do not have explicit regulations on special crossings. Thus, the Wisconsin Administrative Code NR 811.76 for surface water crossings and WisDOT standards for trenchless construction underneath highways have been utilized. These standards are summarized below and will be followed throughout the development of design.

- **Surface Water Crossings:** In general, trenchless construction via Horizontal Directional Drilling (HDD) will be used to cross waterways and large wetlands to minimize the environmental impacts and permitting challenges associated with restoration and habitat disruption. WDNR specifies that underwater crossings will need to provide a minimum cover of two feet. Special consideration in design will be given for higher pressures and pipe wall thickness that may require use of the jack and bore method to cross waterways at some locations.
- **Road or Highway Crossings:** For casing crossings underneath roads and highways, WDNR does not provide design standards. WisDOT states that, at a minimum, trenchless construction is to extend beneath the entire highway prism (from toe of inslope to toe of inslope, or from back of curb to back of curb). Pits are required to be located outside the clear zone so as to not interfere with highway drainage. When specifically authorized by WisDOT, the extent of the trenchless crossing may be reduced or eliminated where such construction methods are impractical or physically restricted by the terrain.
- **Railroad Crossings:** No railroad crossings are encountered on the Water Supply Pipeline route alternatives considered as part of this Study.

Consideration will be given for cobbles during any jack and bore operation for trenchless construction, as cobbles roughly half the pipe diameter or larger have the potential to impede construction. In order to alleviate construction challenges related to cobbles, tunnels may have to be oversized to remove large diameter cobbles. This will allow room for breaking up the cobbles with jackhammers inside the tunnel. Additional soil borings will be collected during design at anticipated working and receiving pits to determine soil types, sheeting requirements, and the presence of cobbles.

Refer to **Section 5.1.2** for tables detailing each special crossing for the three route alternatives identified for evaluation as part of this Study, along with the permits required and potential schedule impacts.

SECTION 3 Route Alternative Development

This Study included the development and evaluation of feasible route sub-alternatives. As discussed during the Route Study Meeting: Water Supply Route Development (4-100 M-04) held with WWU on November 30, 2017, a high-level evaluation of feasible route sub-alternatives was utilized to identify three route alternatives (referred to as Route Alternatives M1, M2, and M3). A more detailed evaluation has been performed on the three route alternatives to identify a preferred route (refer to **Section 4**, **Section 5**, and **Section 6** for details). The following sections describe the process used to identify three route alternatives.

3.1 Route Alternative Selection for Route Study

The Milwaukee Route Study Area was evaluated to identify feasible route sub-alternatives. The evaluation proceeded from east to west, beginning at the anticipated connection to the MWW distribution system near the intersection of 60th Street and Howard Avenue in Milwaukee and ending at the anticipated BPS location at Minooka Park in Waukesha County. To generate a manageable number of route sub-alternatives for the evaluation, the Milwaukee Route Study Area was separated into three panels as follows and shown on **Figure 3-1**. The panels are arranged to follow the flow path starting at the anticipated connection to the MWW distribution system and ending at the anticipated BPS location.

- Panel 1 – 60th Street to Interstate 41
- Panel 2 – Interstate 41 to Moorland Road
- Panel 3 – Moorland Road to BPS

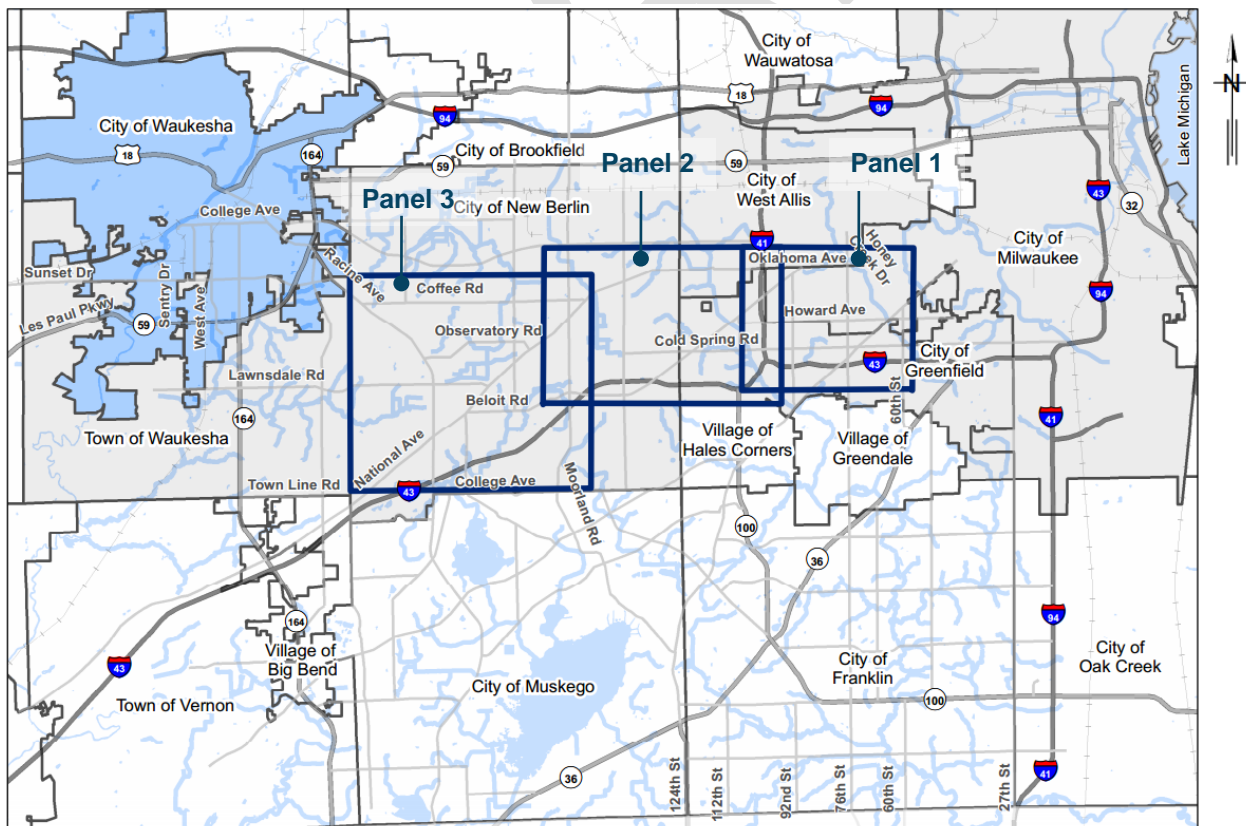


Figure 3-1 Route Sub-Alternatives Panels Key Map

The nature of the existing right-of-way between the BPS and the anticipated connection to WWU's distribution system eliminated the need to evaluate route alternatives downstream of the BPS. For this segment, the route alternatives utilize the same route (referred to as the "Common Route"), that follows Racine Avenue and Sunset Drive to the anticipated connection to WWU's distribution system.

Route sub-alternatives were identified in each panel that would allow the development of three distinct route alternatives and limit duplication of overlapping corridors. To accomplish this objective, route sub-alternatives with the same starting and ending points on each panel were evaluated based on economic and non-economic criteria. This method allowed for the evaluation of a manageable number of route sub-alternatives, while suiting the purpose of generating three route alternatives that utilize predominantly distinct corridors. In accordance with this rationale, the route sub-alternatives were identified and numbered to reflect the route alternative and panel to which they are associated as shown on **Figure 3-2**.

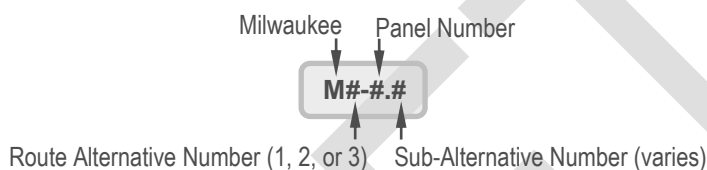


Figure 3-2 Route Sub-Alternative Nomenclature

After identification, route sub-alternatives with the same Route Alternative Number and Panel Number were evaluated and compared to each other based on the economic and non-economic evaluation criteria listed below. Note that significant features are surface conditions that would cause additional challenges during design and construction and include items such as a school, electrical substation, high voltage electrical transmission utility corridor, or stakeholder feedback received during Open Houses held during the Study.

- | | | |
|-------------------------------|---------------------------|-----------------------------|
| • Sub-alternative length | • Total special crossings | • Potential wetland impacts |
| • Traffic | length | • Constructability |
| • Right-of-way width | • Number of easements | • Existing utilities |
| • Number of special crossings | • Total easements length | • Significant features |

The following sections describe the process used to identify route sub-alternatives, the route sub-alternatives identified, the economic and non-economic evaluation of route sub-alternatives, and the preferred route sub-alternatives selected for further evaluation as part of Route Alternatives M1, M2, and M3.

3.1.1 Panel 1 – 60th Street to Interstate 41

For the purposes of this Study, the Water Supply Pipeline begins at the intersection of 60th Street and Howard Avenue in Milwaukee. The Water Supply Pipeline proceeds west from the connection point and crosses Interstate 41. Municipalities within Panel 1 include Milwaukee, Greenfield, and West Allis. The land type around this area is urban and the land use is a mix of residential and commercial.

3.1.1.1 Selected Panel Limits

Panel 1 was developed to extend east to west from 60th Street to Interstate 41. Four Interstate 41 crossing locations were identified west of the connection point. These include two crossings north of the connection point (Oklahoma

Avenue and Beloit Road), one crossing due west of the connection point (Howard Avenue), and one crossing south of the connection point (Cold Spring Road). These crossing locations are shown on **Figure 3-3**.

The anticipated BPS location is nearly due west from the anticipated connection to the MWW distribution system and, therefore, any crossing further north of Oklahoma Avenue or south of Cold Spring Road would extend the length of the Water Supply Pipeline with no benefit to WWU. Thus, the north and south limits of Panel 1 were delineated to encompass the north and south Interstate 41 crossings at Oklahoma Avenue and Cold Spring Road, respectively.

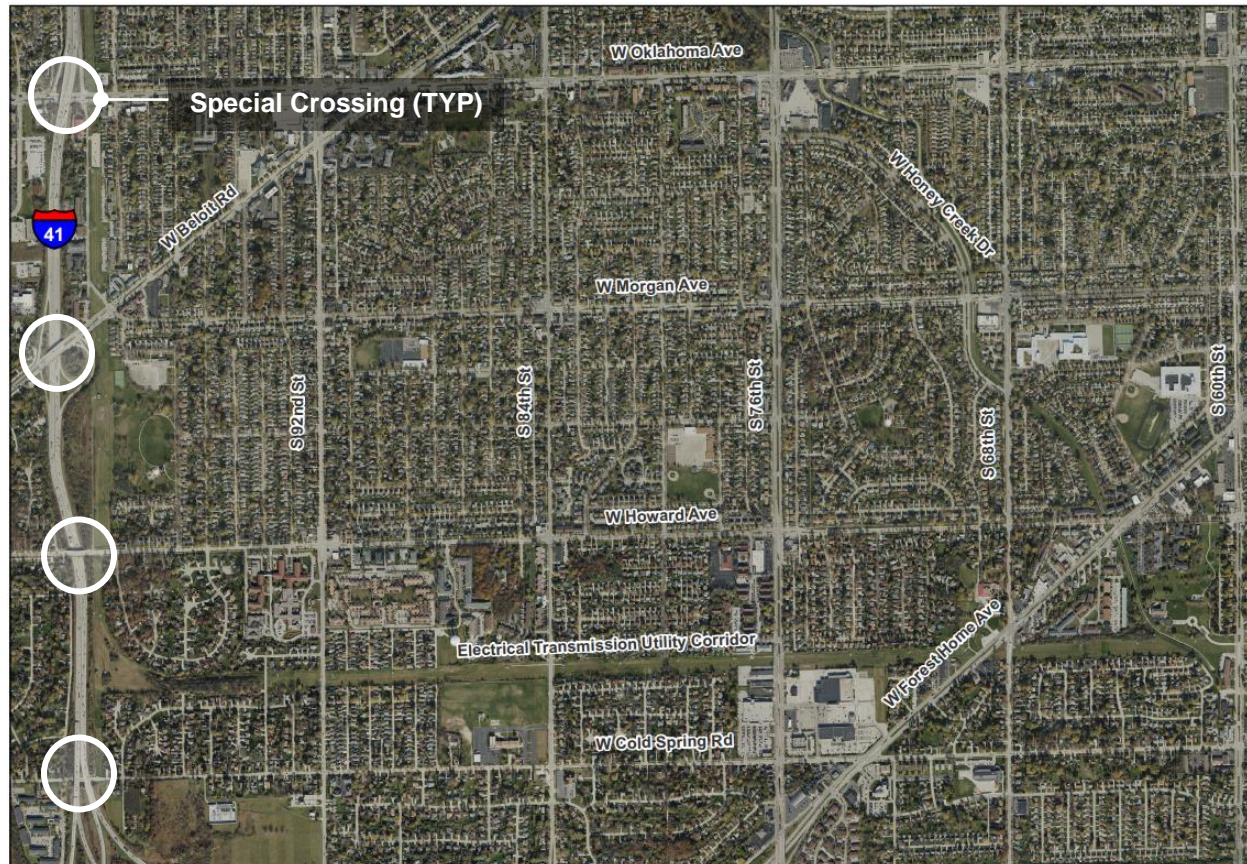


Figure 3-3 Potential Interstate 41 Special Crossing Locations

Field reconnaissance was completed on November 14 and 29, 2017 and the four Interstate 41 crossing locations were evaluated. Both Beloit Road and Howard Avenue interstate crossings are comprised of bridged crossings where the roads cross over Interstate 41. At these locations, Interstate 41 is depressed over 20 feet below the grade on the east and west sides of the interstate, which would require special crossing via trenchless construction approximately 35 feet below grade of the entry and receiving pits. In contrast, Interstate 41 passes over both Oklahoma Avenue and Cold Spring Road, which allows for a shallower installation.

It was determined crossing Interstate 41 at either Beloit Road or Howard Avenue would be less cost-effective than crossing at Oklahoma Avenue or Cold Spring Road. As a result, route sub-alternatives were developed to create two distinct route alternatives in Panel 1 from the connection point at 60th Street and Howard Avenue to the more preferable Interstate 41 crossings at Oklahoma Avenue and Cold Spring Road.

3.1.1.2 Evaluation of Feasible Corridors

Panel 1 is predominantly comprised of an area of gridded street corridors, including the north-south collector and arterial roads of 60th, 68th, 76th, 84th, 92nd, and 100th Streets, and the east-west collector and arterial roads of Oklahoma Avenue, Morgan Avenue, Wilbur Avenue, Howard Avenue, and Cold Spring Road, as well as a High Voltage Electrical Transmission Utility Corridor. The number of corridors allows for a large number of feasible route sub-alternatives. Thus, several less preferable corridors were initially eliminated based on surface conditions, traffic, and visible existing utilities to produce a manageable number of route sub-alternatives for the evaluation.

Average Daily Traffic (ADT) counts as reported by WisDOT were collected and reviewed for the evaluation. Refer to **Figure 3-4** for a summary of the ADT counts on Panel 1. Corridors with lower ADT counts are shaded green, while corridors with higher ADT counts are shaded red. Visible existing utilities were identified during field reconnaissance and are summarized on **Figure 3-5**. Corridors with a lower potential for existing utilities are shaded green, while corridors with a higher potential for existing utilities are shaded red. The following corridors were eliminated from further consideration based on ADT counts, the potential for existing utilities, and/or surface conditions.

- **100th Street:** 100th Street is aligned parallel to a High Voltage Electrical Transmission Utility Corridor that is congested with multiple above grade electrical utilities. Construction in this corridor would require additional care to avoid conflict with overhead power lines. Were a metallic Water Supply Pipeline material to be used, the pipeline would also require cathodic protection for both corrosion control and to manage stray current from the electrical utility. Thus, 100th Street was removed from further consideration to eliminate construction and cathodic protection challenges associated with this corridor.
- **60th Street:** Visible surface markings and confirmation from MWW have indicated a 54-inch trunk main owned by MWW runs beneath 60th Street in the north-south direction. Installing the Water Supply Pipeline beneath 60th Street could pose a risk to the 54-inch trunk main during construction and would reduce redundancy between the Water Supply Pipeline and the MWW distribution system. Thus, 60th Street was eliminated from further consideration to reduce conflict with the 54-inch trunk main.
- **Howard Avenue:** Howard Avenue is comparable to Cold Spring Road in terms of right-of-way width, land use, and potential for existing utilities. Howard Avenue has slightly higher ADT counts than Cold Spring Road. In addition, the Interstate 41 crossing at Howard Avenue was determined less preferable than at Cold Spring Road or Oklahoma Avenue. For these reasons, Howard Avenue was not considered further.
- **Wilbur Avenue:** Wilbur Avenue has a higher density of residential dwellings than other corridors and includes segments with canopied tree cover. Construction in this corridor would pose a risk to trees. Wilbur Avenue was eliminated from further consideration so as to not pose a risk to trees and to reduce public impacts associated with anticipated challenges of constructing the pipeline in close proximity to residents.
- **Local Streets:** Numerous local residential streets, narrower in width than the corridors on the list above, were eliminated from consideration so as to avoid construction that would be disruptive to residents.

Note that the east-west portion of the High Voltage Electrical Transmission Utility Corridor (corridor), owned by We Energies, was evaluated between Howard Avenue and Cold Spring Road. The corridor contains a high voltage electrical transmission tower, with an additional tower planned for future construction. There is an existing gas transmission pipeline within the same corridor. With the existing and planned utilities, there is still sufficient space to install the Water Supply Pipeline. A meeting was held with We Energies on January 23, 2018, and We Energies indicated they were open to allowing access to the corridor for installation of the Water Supply Pipeline. Thus, the High Voltage Electrical Transmission Utility Corridor was included as a route sub-alternative in the evaluation. Similar to 100th Street, were a metallic Water Supply Pipeline material to be used, the pipeline would require cathodic protection for corrosion control and to manage stray current from the high voltage electrical transmission lines.

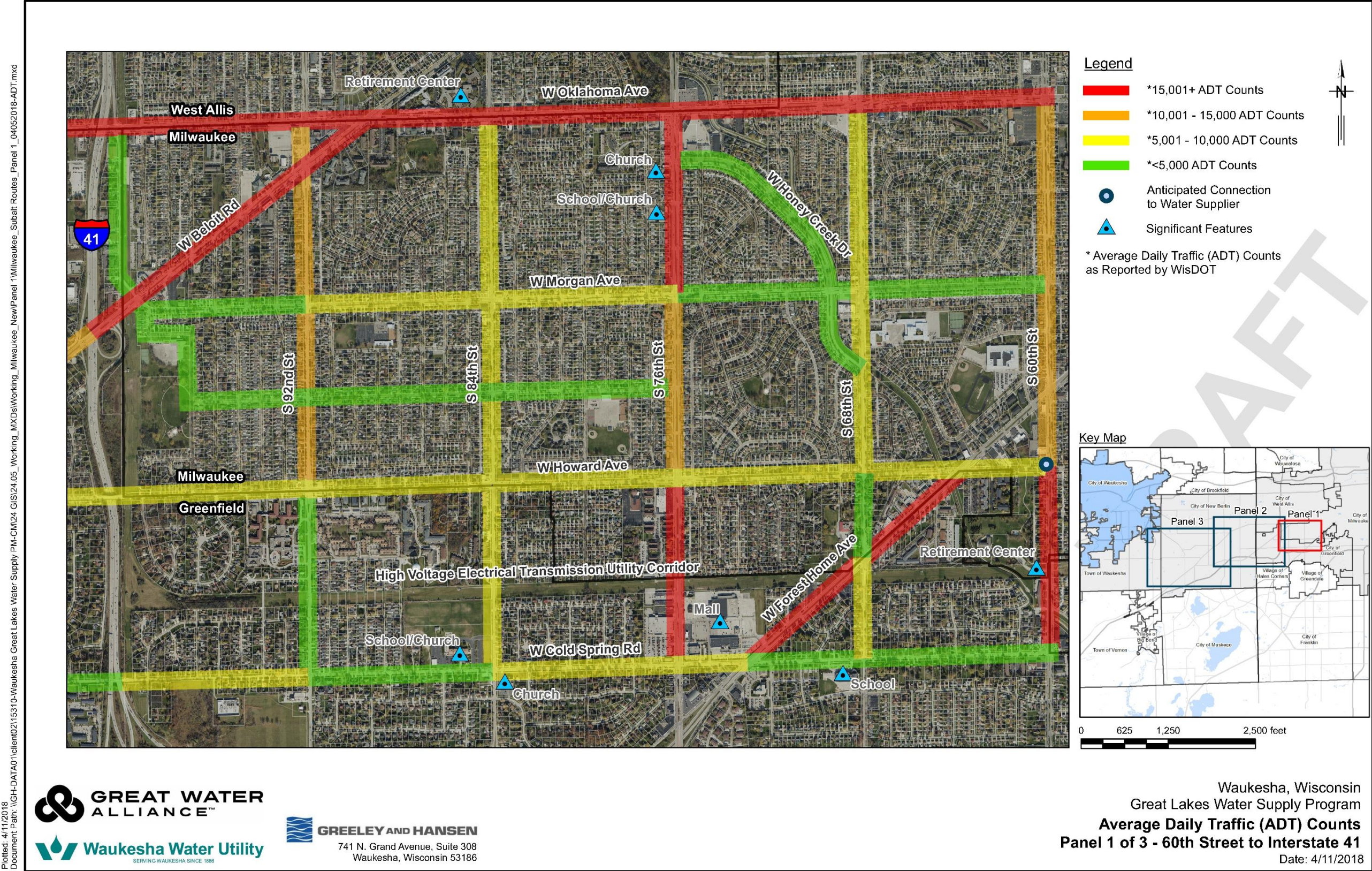


Figure 3-4 Average Daily Traffic Counts Panel 1 of 3 – 60th Street to Interstate 41

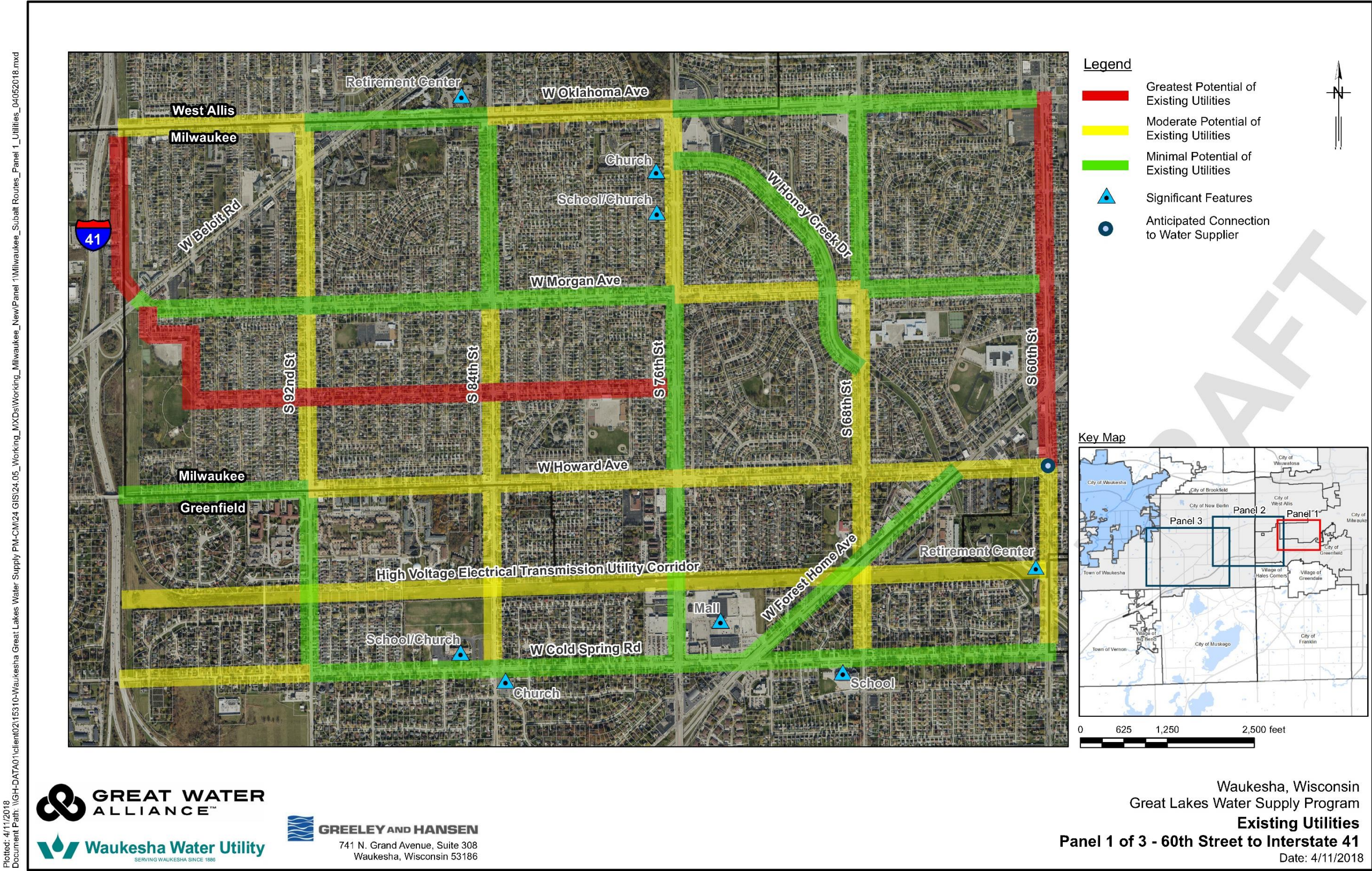


Figure 3-5 Existing Utilities Panel 1 of 3 – 60th Street to Interstate 41

The remaining corridors were evaluated to develop route sub-alternatives shown on **Figure 3-6**. Route sub-alternatives directed to the Interstate 41 crossing at Oklahoma Avenue were associated with Route Alternative M1, while route sub-alternatives directed to the Interstate 41 crossing at Cold Spring Road were associated with Route Alternative M2. Since two feasible Interstate 41 crossing locations were identified, it was determined there was no need to identify a third route alternative in Panel 1. Note that route sub-alternatives associated with Route Alternative M2 are also associated with Route Alternative M3. Refer to **Section 3.1.2.3** for details regarding where Route Alternative M3 diverts from Route Alternative M2.

3.1.1.3 Panel 1, Route Alternative M1

The remaining corridors between the anticipated water supply connection at 60th Street and Howard Avenue and the Interstate 41 crossing at Oklahoma Avenue were utilized to develop route sub-alternatives associated with Route Alternative M1. Four route sub-alternatives were identified as Route Sub-Alternative M1-1.1 through M1-1.4. The criteria and comparative metrics per criteria for route sub-alternatives associated with Route Alternative M1 are shown in **Table 3-1**.

Table 3-1 60th Street to Interstate 41 – Route Alternative M1

Item	Route Sub-Alternative			
	M1-1.1	M1-1.2	M1-1.3	M1-1.4
Sub-Alternative Length (feet)	17,700	18,600	18,600	18,600
Traffic	Low / High	Moderate / High	Moderate / High	Low / High
Right-of-Way Width (feet)	100-150	100-150	90-150	90-150
Number of Special Crossings	7	7	7	7
Total Special Crossings Length (feet)	1,600	1,600	1,600	1,600
Number of Easements	0	0	0	0
Total Easements Length (feet)	Not applicable	Not applicable	Not applicable	Not applicable
Potential Wetland Impacts	Low	Low	Low	Low
Constructability	Good	Good	Fair	Fair
Existing Utilities	Minimal	Moderate	Minimal	Minimal / Moderate
Significant Features	Church, Retirement Center	Church, Retirement Center, School	Retirement Center	-

Route sub-alternatives were reviewed with WWU during the Route Study – Water Supply Route Development Meeting (4-100 M-04) held on November 30, 2017. It was determined the Study would proceed with Route Alternative M1 between 60th Street and Interstate 41 utilizing Route Sub-Alternative M1-1.1 along Honey Creek Drive and Oklahoma Avenue. Route Sub-Alternative M1-1.1 was selected due to its shorter pipeline length and lower potential for existing utilities than the other route sub-alternatives.

3.1.1.4 Panel 1, Route Alternatives M2 and M3

The remaining corridors between the water supply connection at 60th Street and Howard Avenue and the Interstate 41 crossing at Cold Spring Road were utilized to develop route sub-alternatives associated with Route Alternatives M2 and M3. Four route sub-alternatives were identified as Route Sub-Alternative M2-1.1 through M2-1.4.

The criteria and comparative metrics per criteria for route sub-alternatives associated with Route Alternatives M2 and M3 are shown in **Table 3-2**.

Plotted: 4/11/2018
Document Path: \\G:\HDATA\01\client\0215310-Waukesha Great Lakes Water Supply PM-CM24 GIS\24_05_Working_MXD\Working_Milwaukee_New\Panel 1 MASTER_04052018.mxd

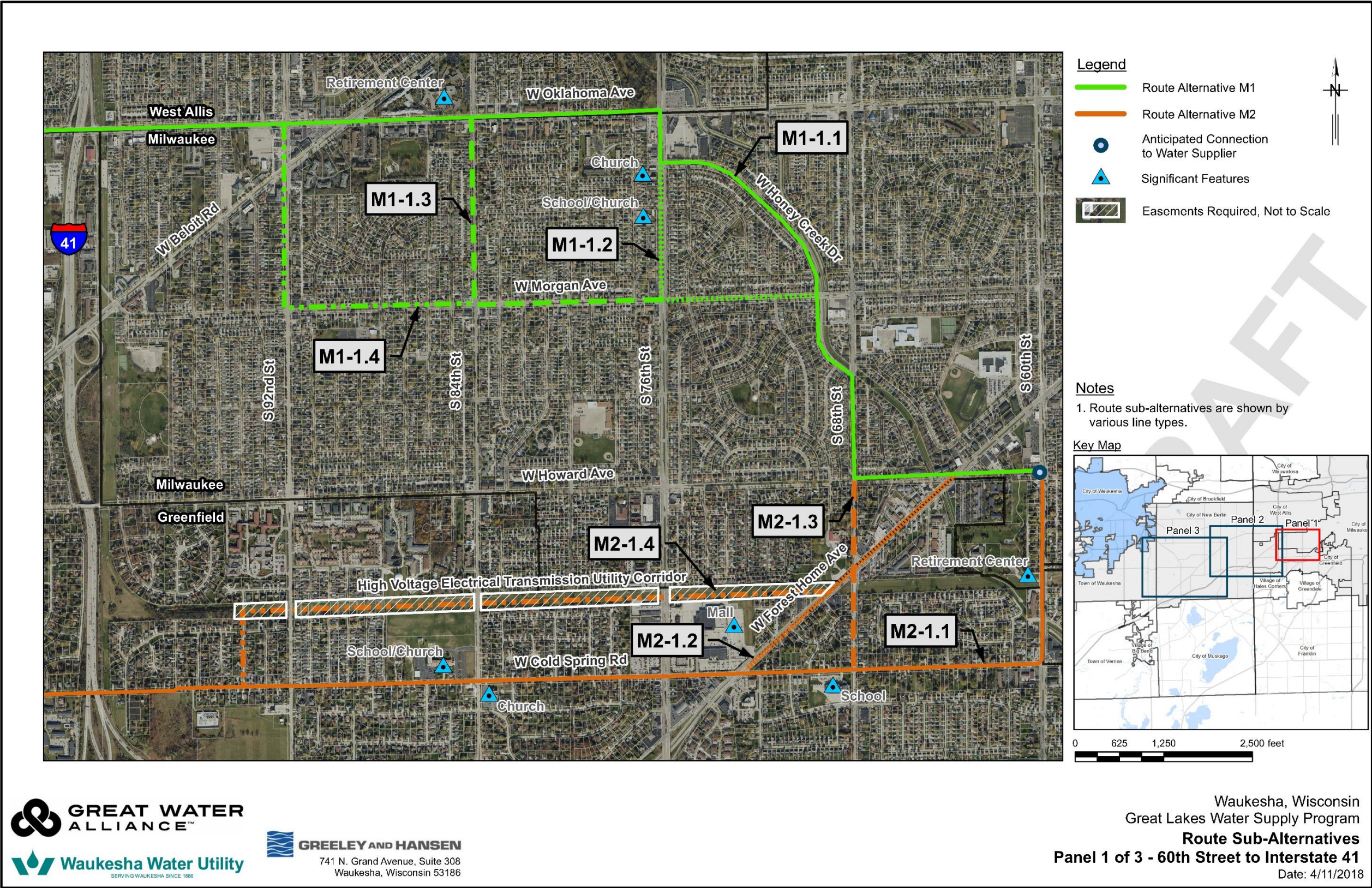


Figure 3-6 Route Sub-Alternatives Panel 1 of 3 – 60th Street to Interstate 41

Table 3-2 60th Street to Interstate 41 – Route Alternatives M2 and M3

Item	Route Sub-Alternative			
	M2-1.1	M2-1.2	M2-1.3	M2-1.4
Sub-Alternative Length (feet)	16,100	14,500	16,100	15,100
Traffic	High / Low	High / Low	Moderate / Low	Low
Right-of-Way Width (feet)	90-110	90-120	90-110	60-100
Number of Special Crossings	5	5	6	6
Total Special Crossings Length (feet)	900	900	1,600	1,000
Number of Easements	0	0	0	14
Total Easements Length (feet)	Not applicable	Not applicable	Not applicable	8,000
Potential Wetland Impacts	Low	Low	Low	Moderate
Constructability	Fair	Good	Fair	Poor
Existing Utilities	Minimal / Moderate	Minimal	Minimal / Moderate	Moderate
Significant Features	Church, Mall, Retirement Center, School	Church, Mall, School	Church, Mall, School	High Voltage Electrical Transmission Utility Corridor

After evaluating the High Voltage Electrical Transmission Utility Corridor, it was determined the corridor was not a preferred route sub-alternative for the Water Supply Pipeline. This is attributed to the corridor's additional required easements, overall length relative to shorter route sub-alternatives, potential for additional cathodic protection requirements if a metallic pipe material were to be used, and constructability challenges associated with work near high voltage electrical transmission lines.

Route sub-alternatives were reviewed with WWU during the Route Study – Water Supply Route Development Meeting (4-100 M-04) held on November 30, 2017. It was determined the Study would proceed with Route Alternatives M2 and M3 between 60th Street and Interstate 41 utilizing Route Sub-Alternative M2-1.2 along Forest Home Avenue and Cold Spring Road. Route Sub-Alternative M2-1.2 was selected due to shorter pipeline length, lower potential for existing utilities, shorter special crossing length, and no easements requirements.

3.1.2 Panel 2 – Interstate 41 to Moorland Road

The Water Supply Pipeline will need to proceed west from Interstate 41 to Moorland Road. Panel 2 was developed to extend from Interstate 41 to Moorland Road as shown on **Figure 3-7**. Municipalities within Panel 2 are Greenfield, West Allis, and New Berlin. The land type is suburban and the land use is mixed residential and commercial.

3.1.2.1 Selected Panel Limits

From an initial review of Panel 2, three wide east-west corridors extend west from the two preferred Interstate 41 crossings at Oklahoma Avenue and Cold Spring Road. Each of the three east-west corridors were associated with one of the three route alternatives, as follows.

- **Route Alternative M1:** Oklahoma Avenue, National Avenue, and Coffee Road
- **Route Alternative M2:** Cold Spring Road
- **Route Alternative M3:** Cold Spring Road and Beloit Road

Plotted: 4/11/2018
Document Path: \\G:\HDATA\01\client\02115310-Waukesha Great Lakes Water Supply PM-CM\24 GIS\24_05_Working_MXD\Working_Milwaukee_New\Panel 2\Milwaukee_Subalt Routes_Panel 2_04052018.mxd

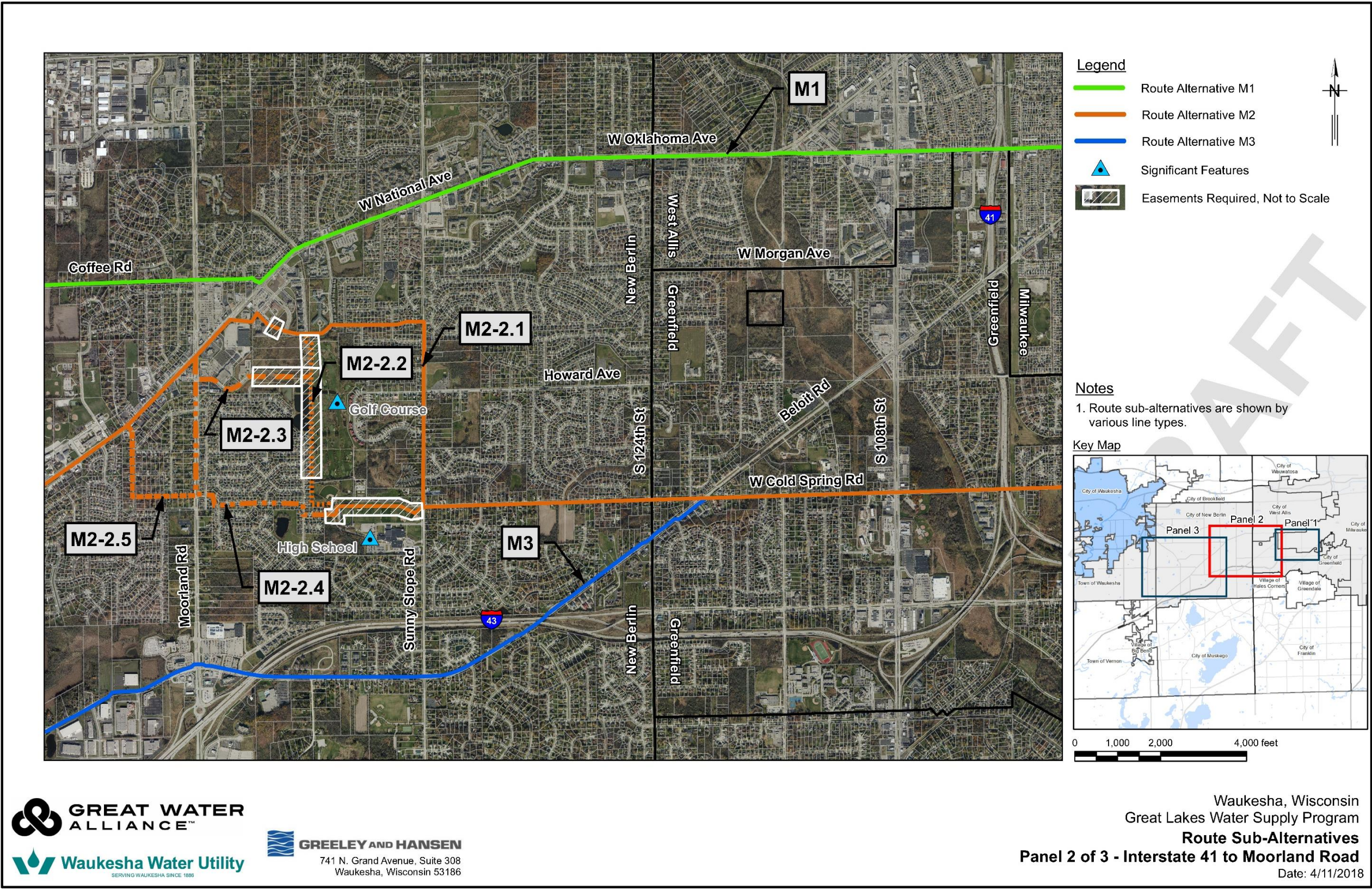


Figure 3-7 Route Sub-Alternatives Panel 2 of 3 – Interstate 41 to Moorland Road

The north extent of Panel 2 was delineated to include the north Interstate 41 crossing at Oklahoma Avenue, while the southern extent was delineated to include Beloit Road, which diverts from Cold Spring Road west of the Interstate 41 crossing. The anticipated BPS location is nearly due west of the anticipated connection to the MWW distribution system and, therefore, any route further north of Oklahoma Avenue or south of Beloit Road would extend the length of the Water Supply Pipeline with no benefit to WWU. Note that similar to the evaluation performed in Panel 1, ADT counts and the potential for existing utilities were also reviewed for Panel 2. Given the Interstate 41 crossing locations and the nature of the east-west corridors denoted above, these items did not play a significant role in the elimination of corridors for the purposes of identifying route sub-alternatives. As a result, ADT counts and the potential for existing utilities figures are not shown for Panel 2.

3.1.2.2 Panel 2, Route Alternative M1

The above corridors were further reviewed with WWU during the Route Study – Water Supply Route Development Meeting (4-100 M-04) held on November 30, 2017. As shown on **Figure 3-7**, it was determined that Route Alternative M1 would proceed west along Oklahoma Avenue from Interstate 41 to National Avenue, continue along National Avenue to Coffee Road, and then proceed along Coffee Road to Moorland Road. Any deviation from these corridors would divert Route Alternative M1 into residential neighborhoods with more narrow corridors that could cause more disruption to residents, while also adding length to the Water Supply Pipeline with no benefit to WWU.

3.1.2.3 Panel 2, Route Alternative M2

Cold Spring Road extends due west across Panel 2 from its crossing at Interstate 41 and ends at Sunny Slope Road just east of New Berlin Eisenhower Middle/High School. Any deviation from Cold Spring Road between Interstate 41 and Sunny Slope Road would divert Route Alternative M2 onto narrower, local streets and residential neighborhoods, while adding length to the Water Supply Pipeline. Thus, Route Alternative M2 proceeds west along Cold Spring Road to Sunny Slope Road.

The remaining extent of Route Alternative M2 between Sunny Slope and Moorland Roads was further evaluated via five route sub-alternatives, Route Sub-Alternatives M2-2.1 through M2-2.5, as shown on **Figure 3-7**. The criteria and comparative metrics per criteria for route sub-alternatives associated with Route Alternative M2 are shown in **Table 3-3**.

Table 3-3 Interstate 41 to Moorland Road – Route Alternative M2

Item	Route Sub-Alternative				
	M2-2.1	M2-2.2	M2-2.3	M2-2.4	M2-2.5
Sub-Alternative Length (feet)	26,200	25,500	24,700	24,600	22,400
Traffic	Moderate	Moderate	Low	Low	Moderate
Right-of-Way Width (feet)	60-115	60-115	55-115	60-115	55-115
Number of Special Crossings	6	7	6	6	5
Total Special Crossings Length (feet)	1,950	2,450	2,850	1,750	1,400
Number of Easements	1	4	3	1	1
Total Easements Length (feet)	200	3,700	4,300	2,700	2,700
Potential Wetland Impacts	Low	Moderate	Moderate	Low	Low
Constructability	Fair	Fair	Fair	Fair	Fair
Existing Utilities	Moderate	Moderate	Moderate	Moderate	Moderate
Significant Features	Residential Neighborhood	High School, Golf Course	High School, Golf Course	High School, Residential Neighborhood	High School, Residential Neighborhood

Route sub-alternatives were reviewed with WWU during the Route Study – Water Supply Route Development Meeting (4-100 M-04) held on November 30, 2017. It was determined the Study would proceed with Route Alternative M2 between Sunny Slope and Moorland Roads utilizing Route Sub-Alternative M2-2.5 along Cold Spring Road, Fenway Drive, and Mayflower Drive. Route Sub-Alternative M2-2.5 was selected due to its shorter pipeline length and fewer special crossings.

3.1.2.4 Panel 2, Route Alternative M3

Interstate 43 is an east-west corridor on the bottom half of Panel 2. Four feasible Interstate 43 crossing locations were identified along Interstate 43 for Route Alternative M3. These include one crossing at 124th Street, two crossings at Beloit Avenue, and one crossing at Sunny Slope Road, as shown on **Figure 3-8**.

Field reconnaissance was completed on November 14 and 29, 2017 and the four Interstate 43 crossing locations were reviewed. Both 124th Street and Sunny Slope Road cross over Interstate 43. At these locations, the elevation of Interstate 43 is approximately 20 feet below the elevation grade north and south of the interstate. The difference in elevation could require special crossing via trenchless technology of more than 30 feet below grade at the entry and receiving pits. In contrast, Interstate 43 passes over both Beloit Road crossings, which would allow for a more shallow installation. It was determined crossing Interstate 43 at either 124th Street or Sunny Slope Road would be less cost-effective than crossing at either Beloit Road crossing.

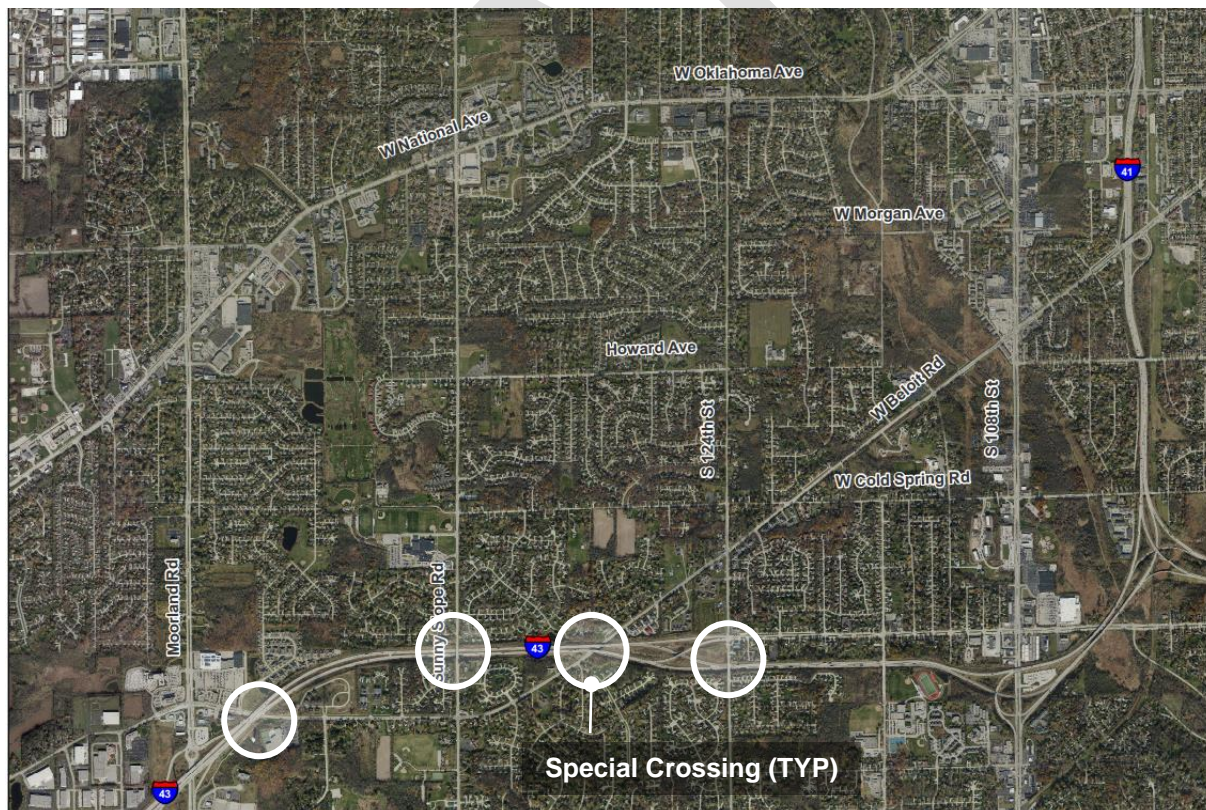


Figure 3-8 Potential Interstate 43 Special Crossing Locations

The Interstate 43 crossing locations were reviewed with WWU the Route Study – Water Supply Route Development Meeting (4-100 M-04) held on November 30, 2017. It was determined the east-west corridor extending west from the Cold Spring Road Interstate 41 crossing to Beloit Road, and proceeding west on Beloit Road to Moorland Road

would be identified as Route Alternative M3. Any deviation from these corridors would extend the route into more narrow, residential corridors, while adding length to the Water Supply Pipeline with no benefit to WWU.

3.1.3 Panel 3 – Moorland Road to Booster Pumping Station

To convey flow to Waukesha, the Water Supply Pipeline will need to proceed west from Moorland Road to the BPS. Panel 3 is shown on **Figure 3-9** and was developed to extend east to west from Moorland Road to Racine Avenue. Municipalities within this area include New Berlin, Waukesha, and the Town of Waukesha. The land type is primarily rural and the land use is a mix of residential and agricultural.

3.1.3.1 Selected Panel Limits

From an initial review of Panel 3, three east-west corridors extend west into Panel 3 from the three route alternatives as described in Panel 2. The three east-west corridors were associated with one of the three route alternatives.

- **Route Alternative M1:** Coffee Road
- **Route Alternative M2:** National Avenue
- **Route Alternative M3:** Beloit Road

The north extent of Panel 3 was delineated to include Coffee Road, while the southern extent was delineated to include Interstate 43 to Racine Avenue. Note that similar to the evaluation in Panels 1 and 2, ADT counts and the potential for existing utilities were reviewed for Panel 3. Given the more rural nature of the east-west corridors denoted above, ADT and existing utilities did not play significant roles in the elimination of sub-alternative corridors.

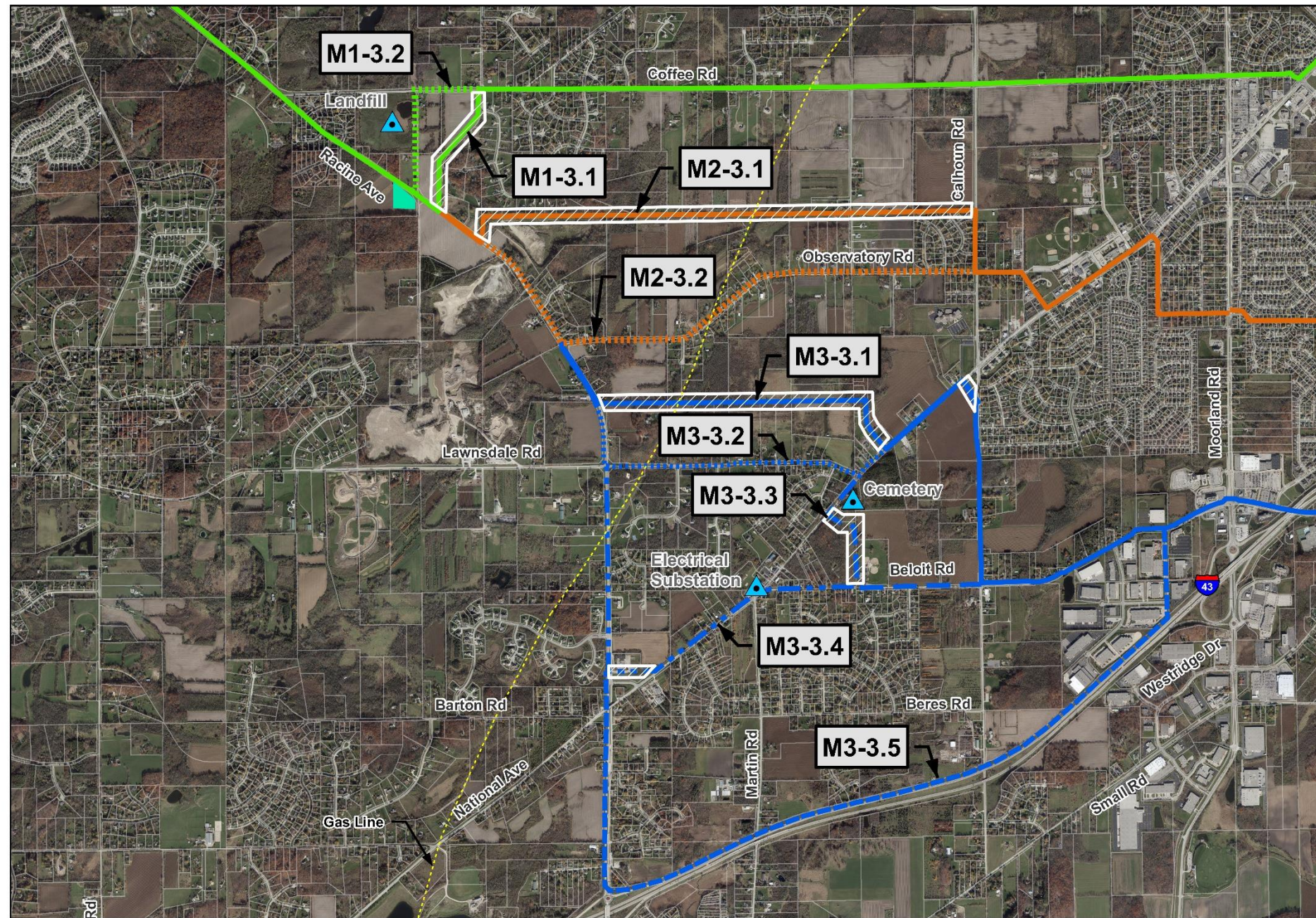
3.1.3.2 Panel 3, Route Alternative M1

The above corridors were reviewed with WWU during the Route Study – Water Supply Route Development Meeting (4-100 M-04) on November 30, 2017. Deviations from Coffee Road would divert Route Alternative M1 to agricultural easements or more narrow corridors, create additional disruption to residents, while adding length to the Water Supply Pipeline with no benefit. It was determined that Route Alternative M1 would proceed west along Coffee Road.

An existing landfill is located southwest of the intersection of Swartz Road and Coffee Road. The remaining extent of Route Alternative M1 between Coffee Road and the BPS was further evaluated via two route sub-alternatives, Route Sub-Alternatives M1-3.1 and M1-3.2, as shown on **Figure 3-9**. Route Alternative M1-3.1 would provide a buffer between the landfill and the Water Supply Pipeline by locating the pipeline east of Swartz Road, with the anticipation that this buffer would avoid potential contaminated soil associated with landfill leachate. If contaminated materials are encountered, procedures may include using special pipe gaskets to address contaminants from degrading the gaskets, or capturing soils for removal/disposal and replacing them with imported fill material.

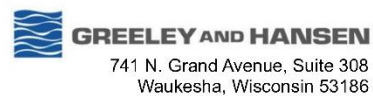
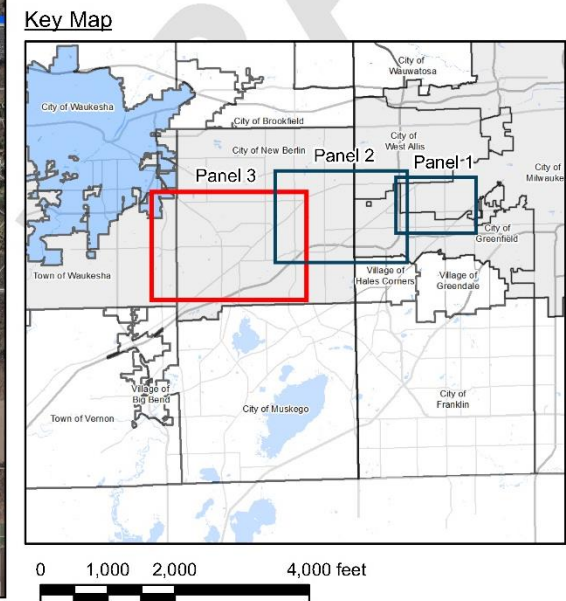
The criteria and comparative metrics per criteria for route sub-alternatives associated with Route Alternative M1 are shown in **Table 3-4**. The two route sub-alternatives were reviewed with WWU during the Route Study – Water Supply Route Development Meeting (4-100 M-04) held on November 30, 2017. It was determined the Study would proceed with Route Alternative M1 between Moorland Road and the BPS utilizing Route Sub-Alternative M1-3.2 along Coffee Road and Swartz Road. Route Sub-Alternative M1-3.2 was selected as it does not require any easements. The Program team analyzed contaminated materials information for the landfill near Route Sub-Alternative M1-3.2 and found no indication of leachate within the right-of-way. Field investigations will be used to detect if leachate along Swartz Road is present and determine the need for design modifications to protect the pipeline against leachate. Additional information regarding leachate near Route Sub-Alternative M3-1.2 is discussed in **Section 5.1.4**.

Plotted: 4/11/2018
Document Path: \\G:\HDATA\01\client\0215310-Waukesha Great Lakes Water Supply PM-CM\24 GIS\24_05_Working\XDS\Working_Milwaukee_New\Panel 3\Milwaukee_Subalt Routes_Panel 3_04052018.mxd



- Legend**
- Route Alternative M1
 - Route Alternative M2
 - Route Alternative M3
 - ▲ Booster Pumping Station
 - ▲ Significant Features
 - Easements Required, Not to Scale
 - Approximate Gas Line Location

- Notes**
1. Route sub-alternatives are shown by various line types.



Waukesha, Wisconsin
Great Lakes Water Supply Program
Route Sub-Alternatives
Panel 3 of 3 - Moorland Road to Booster Pumping Station
Date: 4/11/2018

Figure 3-9 Route Sub-Alternatives Panel 3 of 3 – Moorland Road to Booster Pumping Station

Table 3-4 Moorland Road to Booster Pumping Station – Route Alternative M1

Item	Route Sub-Alternative	
	M1-3.1	M1-3.2
Sub-Alternative Length (feet)	15,300	15,400
Traffic	Low	Low
Right-of-Way Width (feet)	90-110	90-110
Number of Special Crossings	2	2
Total Special Crossings Length (feet)	350	350
Number of Easements	2	0
Total Easements Length (feet)	2,900	Not applicable
Potential Wetland Impacts	Low	Low
Constructability	Good	Good
Existing Utilities	Minimal	Minimal
Significant Features	-	Landfill

3.1.3.3 Panel 3, Route Alternative M2

Route Alternative M2 on Panel 3 proceeds west from Panel 2 along National Avenue. The main east-west corridor follows Observatory Road to Calhoun Road. Any deviation from Observatory Road along this segment would place Route Alternative M2 into agricultural easements or extend the pipeline length along National Avenue. Thus, it was determined Route Alternative M2 would proceed west along Observatory Road to Calhoun Road. The remaining extent of Route Alternative M2 between Calhoun Road and Racine Avenue was further evaluated via two route sub-alternatives, Route Sub-Alternatives M2-3.1 and M2-3.2 as shown on **Figure 3-9**. The criteria and comparative metrics per criteria for route sub-alternatives associated with Route Alternative M2 are shown in **Table 3-5**.

Table 3-5 Moorland Road to Booster Pumping Station – Route Alternative M2

Item	Route Sub-Alternative	
	M2-3.1	M2-3.2
Sub-Alternative Length (feet)	15,100	15,200
Traffic	Low / Moderate	Low / Moderate
Right-of-Way Width (feet)	70-110	55-110
Number of Special Crossings	2	2
Total Special Crossings Length (feet)	550	550
Number of Easements	8	0
Total Easements Length (feet)	10,900	Not applicable
Potential Wetland Impacts	Moderate	Low
Constructability	Fair	Fair
Existing Utilities	Minimal	Minimal
Significant Features	-	-

Route sub-alternatives were reviewed with WWU during the Route Study – Water Supply Route Development Meeting (4-100 M-04) held on November 30, 2017. It was determined the Study would proceed with Route Alternative M2 between Moorland Road and the BPS utilizing Route Sub-Alternative M2-3.2 along National Avenue, Observatory Road, and Racine Avenue. Route Sub-Alternative M2-3.2 was selected as it requires no easements and has a lower potential wetlands impact.

3.1.3.4 Panel 3, Route Alternative M3

Route Alternative M3 on Panel 3 continues west from Panel 2 along Beloit Road. Multiple corridors exist between Mooreland Road and Racine Avenue south of those evaluated for Route Alternative M2 that could be considered as route sub-alternatives for the Water Supply Pipeline.

Route sub-alternatives on Panel 3 are similar to those evaluated for the Return Flow Pipeline (refer to the Draft Route Study: Oak Creek (4-100 D1), Figure 3-4). The route sub-alternatives have been adjusted to accommodate the Water Supply Pipeline with a water supply connection to the MWW distribution system. The route sub-alternatives were further refined due to significant features and stakeholder feedback received during Open House Meetings held in New Berlin on June 29, 2017 for the Return Flow Pipeline and February 15, 2018 for the Water Supply Pipeline.

The corridors compose five route sub-alternatives, Route Sub-Alternatives M3-3.1 and M3-3.5, as shown on **Figure 3-9**. The criteria and comparative metrics per criteria for route sub-alternatives associated with Route Alternative M3 are shown in **Table 3-6**.

Table 3-6 Moorland Road to Booster Pumping Station – Route Alternative M3

Item	Route Sub-Alternative				
	M3-3.1	M3-3.2	M3-3.3	M3-3.4	M3-3.5
Sub-Alternative Length (feet)	20,400	21,100	19,500	21,200	28,400
Traffic	Low	Moderate	Low	Moderate	Low / Moderate
Right-of-Way Width (feet)	60-115	55-115	55-115	60-115	75-150
Number of Special Crossings	2	2	2	2	4
Total Special Crossings Length (feet)	500	500	500	500	400
Number of Easements	8	1	1	1	1
Total Easements Length (feet)	7,400	1,600	1,300	1,700	300
Potential Wetland Impacts	High	Low	Moderate	Low	Moderate
Constructability	Fair	Fair	Fair	Good	Good
Existing Utilities	Minimal	Minimal	Minimal	Moderate	Minimal / Moderate
Significant Features	Potential Stakeholder Challenges	Potential Stakeholder Challenges	Cemetery, Stakeholder Challenges	Electrical Substation	-

Route sub-alternatives were reviewed with WWU during the Route Study – Water Supply Route Development Meeting (4-100 M-04) held on November 30, 2017. It was determined the Study would proceed with Route Alternative M3 between Moorland Road and the BPS utilizing Route Sub-Alternative M3-3.4 along Beloit Road, National Avenue, and Racine Avenue. Route Sub-Alternative M3-3.4 was selected due to fewer potential wetland impacts and fewer anticipated stakeholder challenges. The only required easement along Route Sub-Alternative M3-3.4 is located on an abandoned school property. The easement can be avoided if it is not able to be acquired by extending the pipeline to the intersection of National and Racine Avenues. If the easement was able to be acquired, however, it could also be utilized as a construction laydown area.

3.1.4 Route Alternatives for Route Study

After developing and identifying the three route alternatives in coordination with WWU, the Study proceeded with Route Alternatives M1, M2, and M3. The route alternatives are shown on **Figure 3-10**.

Document Path: G:\15310-Waukesha Great Lakes Water Supply PM-CM\24 GIS\24.05_Working_MXD\Working_Milwaukee_New\Preferred Routes_04052018_CEV.mxd

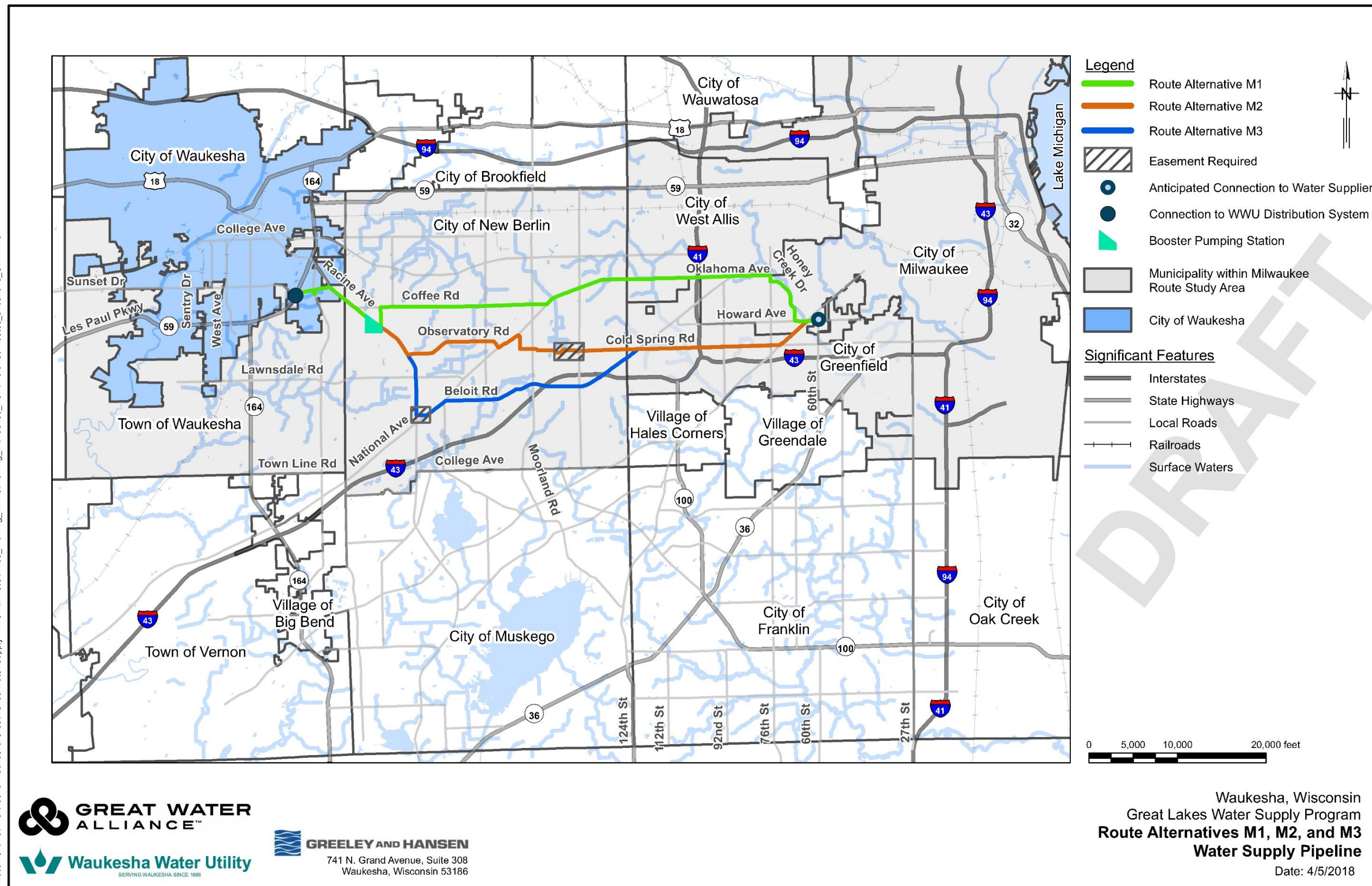


Figure 3-10 Route Alternatives M1, M2, and M3 – Water Supply Pipeline

3.2 Description and Discussion of Route Alternatives M1, M2, and M3

The following sections are narratives that describe Route Alternatives M1, M2, and M3. The descriptions follow the flow path starting at the anticipated connection to the MWW distribution system and proceeding along the Water Supply Pipeline to the connection to WWU's distribution system.

Refer to **Appendix A** for detailed descriptions of the preliminary horizontal alignments for Route Alternatives M1, M2, and M3 alongside photo documentation collected during field reconnaissance. The descriptions provide the rationale behind each route alternative's preliminary horizontal alignment, potential traffic control strategies, and special crossing methods. Note that the preliminary horizontal alignments are provided in **Appendix I** and bound separately from this narrative.

3.2.1 Route Alternative M1

Route Alternative M1 starts at the intersection of Howard Avenue and 60th Street in Milwaukee and continues west along Howard Avenue to 68th Street. The route then proceeds north along 68th Street to Honey Creek Drive, thence northwest on Honey Creek Drive to 76th Street, thence north on 76th Street to Oklahoma Avenue, thence west on Oklahoma Avenue to 124th Street where Oklahoma Avenue becomes National Avenue. The route then continues west along National Avenue to Coffee Road, thence west on Coffee Road to Swartz Road, thence south on Swartz Road to Racine Avenue where the Water Supply Pipeline will discharge into water reservoirs that will be adjacent to the BPS on Parcel NBC 1224994 currently owned by the Waukesha County Park and Planning Department.

From the BPS, the Common Corridor starts and proceeds northwest on Racine Avenue to Sunset Drive, thence west on Sunset Drive to Les Paul Parkway. At the intersection of Sunset Drive and Les Paul Parkway, the Water Supply Pipeline diverts from the Common Corridor to Parcel WAKC 1349999 located on the northwest quadrant of the intersection of Les Paul Parkway and Sunset Drive where the Water Supply Pipeline will pass through the WSCB. From the WSCB, the Water Supply Pipeline will proceed east to Les Paul Parkway where the Water Supply Pipeline is anticipated to connect to WWU's distribution system at a 24-inch trunk main.

3.2.2 Route Alternative M2

Route Alternative M2 starts at the intersection of Howard Avenue and 60th Street in Milwaukee and continues west along Howard Avenue to Forest Home Avenue. The route then proceeds southwest along Forest Home Avenue to Cold Spring Road, thence west on Cold Spring Road to Sunny Slope Road. The route crosses Sunny Slope Road and proceeds onto the northeast corner of the New Berlin Eisenhower Middle/High School property (Parcel NBC 1241994) owned by New Berlin Public Schools. The route continues west on Parcel NBC 1241994 along the north property line to Fenway Drive, thence west on Fenway Drive to Regal Drive, thence north on Regal Drive to Fenway Drive, thence west on Fenway Drive to Mayflower Drive, thence west of Mayflower Drive to Church Drive, thence north on Church Drive to National Avenue. At National Avenue, the route proceeds southwest on National Avenue to Observatory Road, and thence west on Observatory Road to Racine Avenue.

At the intersection of Observatory Road and Racine Avenue, the Common Corridor starts and proceeds northwest on Racine Avenue to Parcel NBC 1224994 currently owned by the Waukesha County Park and Planning Department where the Water Supply Pipeline will discharge into water reservoirs that will be adjacent to the BPS. From the BPS, the route for the Water Supply Pipeline is the same as described above for Route Alternative M1.

3.2.3 Route Alternative M3

Route Alternative M3 starts at the intersection of Howard Avenue and 60th Street and follows the same route as Route Alternative M2 to the intersection of Cold Spring Road and Beloit Road. From the intersection of Cold Spring Road and Beloit Road, Route Alternative M3 proceeds southwest on Beloit Road to National Avenue, thence southwest on National Avenue to the eastern property line of Parcel NBC 1268960 owned by Prospect Hills II LLC where the former Prospect Hill Elementary School is located. The route then proceeds west across Parcel NBC 1268960 to Racine Avenue.

At Racine Avenue, the Common Corridor starts and proceeds northwest to Observatory Road. From the intersection of Observatory Road and Racine Avenue, the route for the Water Supply Pipeline is the same as described above for Route Alternative M2.

SECTION 4 Route Alternatives M1, M2, and M3 Hydraulic Analysis

4.1 General

A hydraulic analysis was performed for Route Alternatives M1, M2, and M3 to evaluate the hydraulic requirements to deliver flow at demand conditions and support the economic and non-economic evaluation of the route alternatives. The hydraulic analysis provides a basis for evaluating preliminary sizes of facilities, pipelines, and other infrastructure along the water supply system. For comparison purposes, the hydraulic analysis was developed in a similar manner to the hydraulic analysis completed for the DRAFT Route Study: Oak Creek (4-100 D1) and will be refined as the Program progresses. The following sections describe the methods, criteria, and results of the hydraulic analysis.

4.2 Water Demands

4.2.1 Approved Diversion

In its Final Decision, the Compact Council approved an Average Day Demand (ADD) of 8.2 million gallons per day (MGD). Per the Application, the Maximum Day Demand (MDD) has been determined to be 1.66 times the 8.2 MGD ADD, or 13.6 MGD. The demand conditions are summarized in **Table 4-1**.

Table 4-1 Demand Conditions per Final Decision

Demand Condition	Demand (MGD)
Approved ADD	8.2
MDD at Approved ADD	13.6

4.2.2 Historical Demands

Twenty-nine calendar years of daily pumped flow data as provided by WWU from January 1, 1988 through December 31, 2016 was reviewed. **Figure 4-1** shows the 30-day moving average overlaid upon the daily pumped flow data with a linear trend line. The 30-day moving average is the average of the previous 30 days of daily pumped flow data and is typically used in statistical analyses to review trends over long intervals. The water demand exhibits a decreasing trend. This decreasing trend may be attributed to general efficiency improvements of the distribution system, conservation measures promoted by WWU, or increased water efficiencies of household and business appliances. Conservation measures implemented in 2006 included conservation water rates, which charged residential customers more per gallon as water use increased. The 13.6 MGD MDD has not been exceeded in over 24 years.

Annual precipitation since 1988 as reported by the Midwestern Regional Climate Center is also provided above the plot of daily pumped flow on **Figure 4-1**. Drought years have been identified as years with an annual precipitation of less than 30 inches as 1988, 1989, 1994, 2003, 2005, and 2012.

Figure 4-2 shows a frequency plot of the daily pumped flow observed over the past 10 calendar years from January 1, 2007 through December 31, 2016. As shown, 95% of day demands range between 5.0 and 8.5 MGD, which are below the 13.6 MGD MDD. The demand demonstrates a normal distribution, indicating day demands above and below the median day demand are comparably likely. The median day demand observed over the last 10 years is 6.6 MGD and was observed on three separate occasions – July 12, 2010, November 22, 2011 and December 9, 2011.

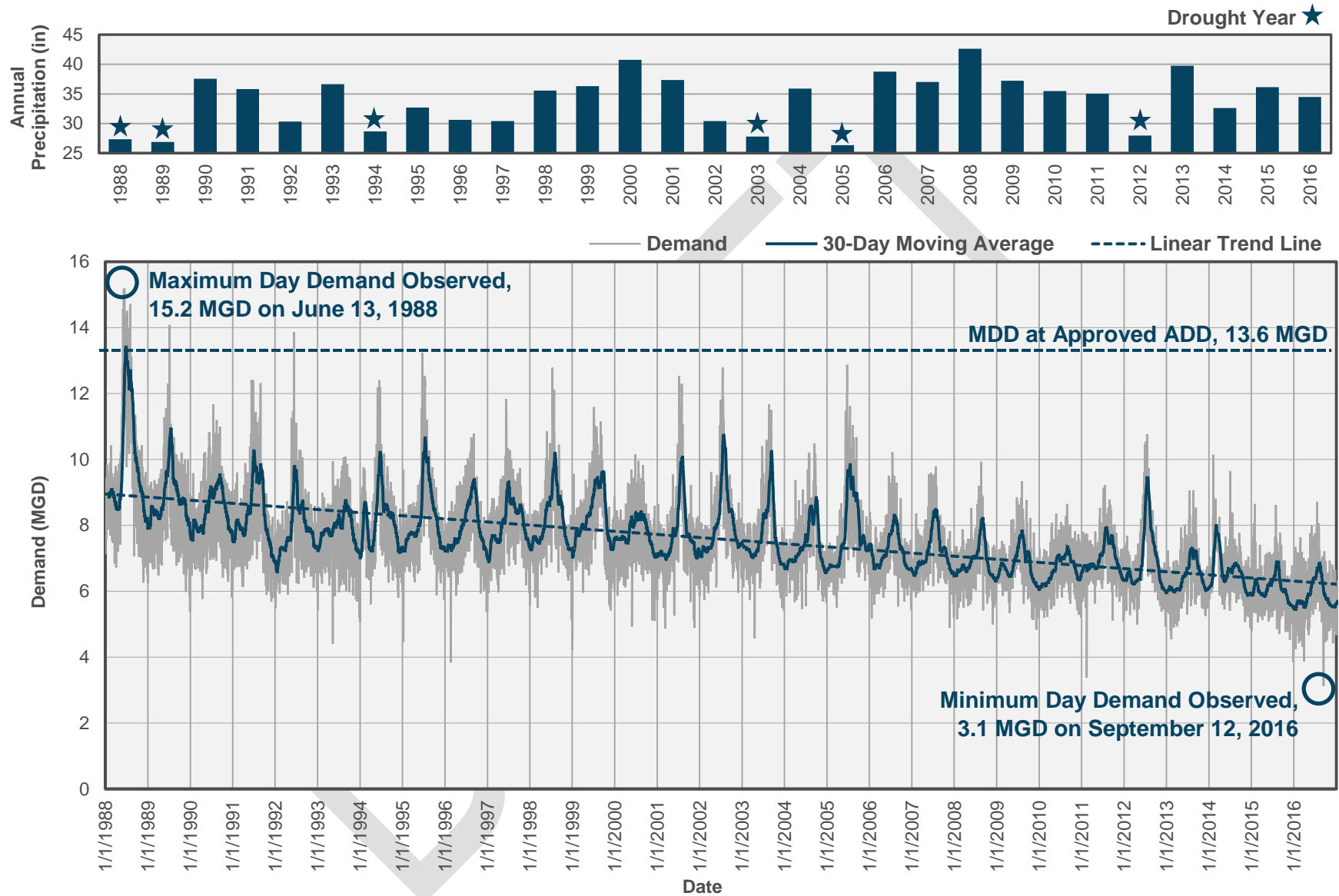


Figure 4-1 29-Year Waukesha Water Demand History – January 1, 1988 through December 31, 2016

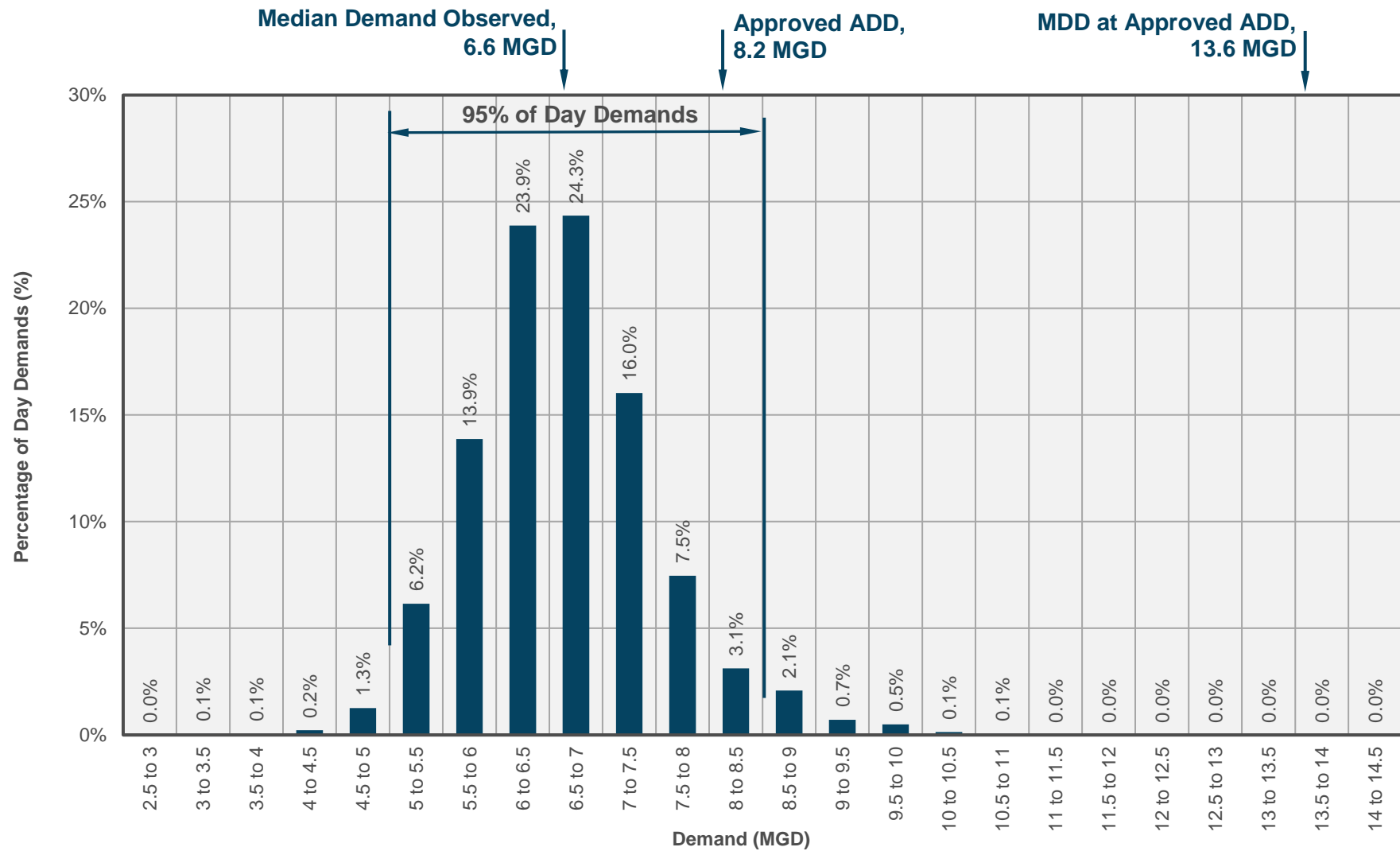


Figure 4-2 10-Year Waukesha Water Demand Frequency – January 1, 2007 through December 31, 2016

4.2.3 Diurnal Demand

The diurnal demand has been developed as a basis for determining flow requirements associated with supplying Waukesha's minimum hour demand and peak hour demand (PHD). Two years of WWU instantaneous flow data from October 2014 through September 2016 was analyzed to develop the diurnal demand curve.

The diurnal demand was calculated by performing a water balance on the distribution system. The instantaneous demand was calculated as the sum of the flow supplied and the differential tank flow in each pressure zone throughout WWU's distribution system. The flow supplied was calculated as the flows through the wells and booster pumping stations throughout the distribution system in all pressure zones. The differential tank flow was calculated as the difference between the flow out of the tank and the flow into the tank. Differential tank flows were calculated based on volume differentials per time step. The instantaneous water demand was averaged for each hour of the day over the data set to develop a system-wide diurnal demand curve for Waukesha. Distribution system modeling efforts also developed diurnal demand curves for each pressure zone throughout WWU's distribution system.

The system-wide diurnal demand for WWU's distribution system is shown on **Figure 4-3** with hour zero associated with midnight. The primary y-axis on the left presents the dimensioned diurnal demand, while the secondary y-axis on the right presents the dimensionless diurnal demand relative to the average demand observed.

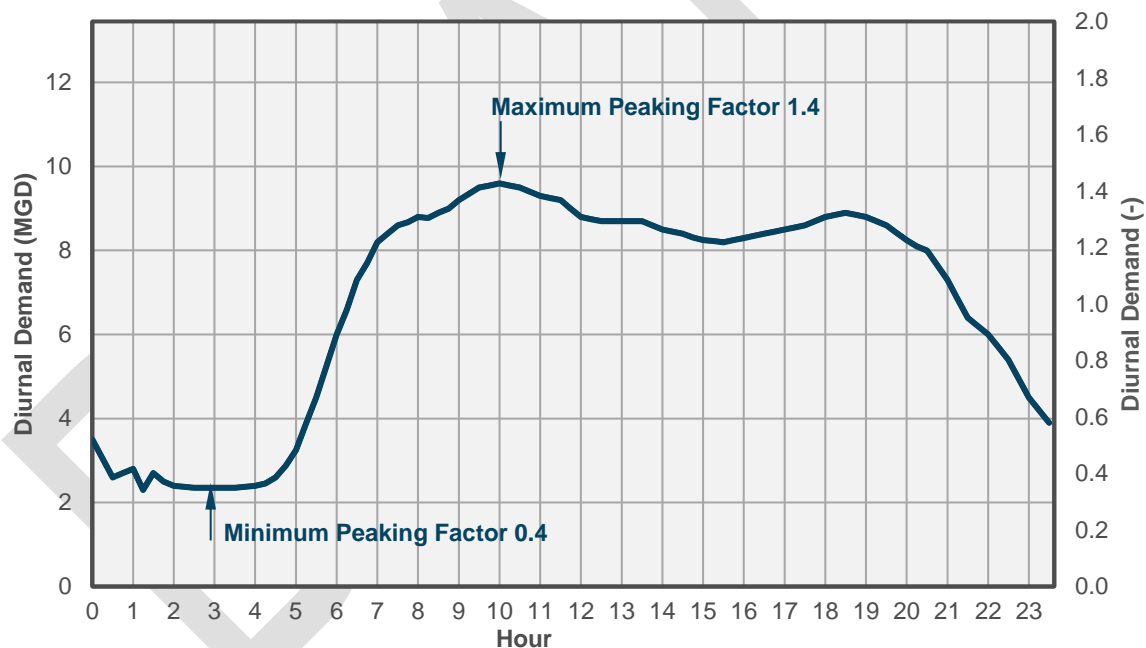


Figure 4-3 Diurnal Demand Curve

As shown, the diurnal demand consists of a variation of a typical diurnal pattern with a minimum flow in the early morning hours as well as two peaks at midmorning and early evening. The dimensionless diurnal demand ranges from a minimum factor of approximately 0.4 to a maximum factor of 1.4. The diurnal demand curve provides information on potential demand variations used to determine pumping rate possibilities for delivery by the BPS, while taking into account attenuation by existing storage throughout WWU's distribution system.

4.2.4 Demands Evaluated

The historical water demands were compared to the Approved Diversion by the Compact Council to determine the selected water demands and flow rates to be used in this Study. The demands were selected to allow planning and design to occur over a large range of anticipated flows. The 13.6 MGD MDD associated with the approved ADD has been used as the upper limit for the Study. The median day demand observed over the last 10 calendar years has been used to represent Waukesha's existing demand and a demand within the range of day demands comparable to those anticipated upon startup. The minimum day and hour demands observed provides the lower limit of the analysis. The demands are summarized below.

- **Peak Hour Demand (PHD):** 19.0 MGD (1.4 [maximum peaking factor] x 13.6 MGD MDD associated with the approved ADD)
- **MDD:** 13.6 MGD (MDD associated with the approved ADD)
- **ADD:** 8.2 MGD (approved ADD)
- **Existing Day Demand:** 6.6 MGD (median demand, January 2007 to December 2016)
- **Minimum Day Demand:** 3.1 MGD (minimum demand, January 1988 to December 2016)
- **Minimum Day Minimum Hour:** 1.2 MGD (0.4 [minimum peaking factor] x 3.1 MGD minimum day demand)

4.3 Hydraulic Analysis Method

The water supply system will require infrastructure located along the Water Supply Pipeline to provide a complete and operational system. These items include pumping stations, water reservoirs, meters, and valves. The following subsections describe the modeling method and results for sizing the water supply system with a Milwaukee water supply.

4.3.1 Concept Overview

The water supply system will require piping and facilities capable of delivering flow from Milwaukee to Waukesha. As a result, the water supply system was evaluated with the following key infrastructure.

- **Water Supply Pumping Station (WSPS):** A WSPS to provide the head to convey flow towards Waukesha.
- **Water Supply Pipeline:** A Water Supply Pipeline to convey flow from the WSPS to the Water Supply Pipeline's connection to WWU's distribution system.
- **Water Reservoirs:** A means for storage between the WSPS and the Water Supply Pipeline's connection to WWU's distribution system to attenuate demands and provide for emergency storage. An air break will be used to protect WWU's distribution system from hydraulic transients in the Water Supply Pipeline and WSPS.
- **Booster Pumping Station (BPS):** A BPS to provide the head necessary to convey flow from the water reservoirs to WWU's distribution system.
- **Water Supply Control Building (WSCB):** A WSCB will house PRVs to reduce Water Supply Pipeline pressures to within a desirable range for WWU's distribution system.
- **Connection to WWU's Distribution System:** The Water Supply Pipeline connection to WWU's distribution system to supply Waukesha with Lake Michigan water.

Key water supply system infrastructure were reviewed during the Alternate Supply Route Review Workshop (Task 4-100 W-02) held with WWU on April 19, 2017 and are shown on **Figure 1-1**. The following sections describe the method used in defining the water supply system infrastructure for the purposes of comparing route alternatives.

4.3.2 Assumptions and Criteria

The following assumptions and criteria were used to develop the hydraulic analysis.

- **WSPS:**

- The WSPS will be located near the intersection of 60th Street and Howard Avenue.
- The WSPS will be sized for a hydraulic capacity of 13.6 MGD MDD over an 18-hour pumping schedule, or an instantaneous throughput of 18.1 MGD, as discussed during the Flow and Pipeline Sizing Considerations Meeting (6-100 M-02) held with WWU on May 4, 2017. The hydraulic capacity is consistent with what was used in the Route Study: Oak Creek (4-100 D1) for comparison purposes. The PDR will include a refined hydraulic capacity of the WSPS as determined in coordination with MWW.

- **Water Supply Pipeline:**

- The maximum steady state design pressure will be set at 225 psi. This will eliminate the need for using a pipe with pressure class above 250 psi. Pressures in excess of 250 psi require thicker pipe walls and non-standard, more robust valves, which would increase cost and complexity of design.
- The minimum steady state design pressure is 35 psi and the minimum allowable steady state pressure is 20 psi per the Wisconsin Administrative Code-PSC, Subchapter VIII – Operating Requirements, Wisconsin Administrative Code-PSC 185.82 – Pressure Standards and the WDNR, Subchapter NR 811.70 – Water Main Design.
- The Water Supply Pipeline will be constructed of Ductile Iron Pipe (DIP) with an absolute roughness of 0.85 millifeet (or a Hazen-Williams Roughness Coefficient, or C, of approximately 130 for a 30-inch nominal diameter pipe at a throughput of 18.1 MGD). Hydraulics through other materials that considers pipeline age will be provided in the PDR and a final decision on pipeline materials will be made during design.
- Minor friction losses, or head losses due to entry and exits, valves, bends, and fittings have not been considered.
- A maximum velocity of 7 fps is desirable for preliminary pipeline sizing to maintain head losses within reasonable tolerance and conserve energy during normal operations.
- Hydraulic transients will be evaluated separately in design to confirm operating conditions when a vertical alignment has been developed and has not been considered as part of this Study.

- **Water Reservoir / BPS:**

- The water reservoirs and BPS will be located on Parcel NBC 1224994 owned by the Waukesha County Department of Parks and Land Use as discussed during the Water Supply Facilities Site Selection Meeting (6-100 M-04) held on May 23, 2017 and the BPS Site and Building Meeting (6-200 M-01) held on June 29, 2017 with WWU.
- The BPS will operate to meet the diurnal demand of Waukesha.
- The water reservoirs and BPS operational configuration is shown on **Figure 4-4** as discussed during the BPS Operation and Discharge Pipeline Evaluation Meeting (6-100 M-07) held on August 2, 2017

with WWU. Flow will be conveyed from the WSPS to a Pressure Sustaining Valve (PSV) upstream of an air break in the water reservoirs. The PSV will maintain a minimum pressure of 35 psi in the Water Supply Pipeline upstream of the water reservoirs. The flow will then be conveyed into the water reservoirs. The BPS will draw from the water reservoirs and provide the head necessary to supply WWU's distribution system.

- Hunter Tower is an existing elevated storage tank located near Sunset Drive in WWU's Southeast Pressure Zone. The BPS will operate based on levels in the Hunter Tower to maintain pressures in excess of 35 psi in the Water Supply Pipeline downstream of the BPS as discussed during the Distribution System Hydraulic Model Meeting (5-100 M-04) held on October 13, 2017 with WWU.

• **WSCB:**

- The WSCB will be located on Parcel WAKC 1349999 owned by WWU on the northwest quadrant of the intersection of Sunset Drive and Les Paul Parkway, as per the Distribution System Hydraulic Model Meeting (5-100 M-04) held on October 13, 2017 with WWU. The WSCB is shown on **Figure 4-4**.
- The WSCB will house PRVs. The PRVs will reduce pressures in the Water Supply Pipeline to within a desirable range for WWU's distribution system.

• **WWU Distribution System:**

- The Water Supply Pipeline will connect to WWU's distribution system near the intersection of Sunset Drive and Les Paul Parkway at a 24-inch trunk main as discussed during the Distribution System Hydraulic Model Meeting (5-100 M-04) held on October 13, 2017 with WWU.

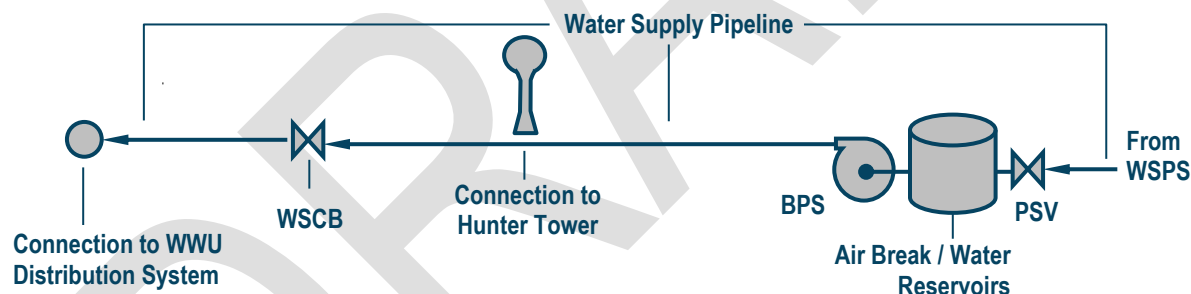


Figure 4-4 Water Reservoirs to Waukesha Water Utility Distribution System Connection Diagram

4.3.3 Pipeline Size

4.3.3.1 Water Supply Pumping Station (WSPS) to Booster Pumping Station (BPS)

InfoWater, a water distribution analysis and design software by Innovyze, was used to simulate the hydraulics of the water supply system. The WSPS was operated at an instantaneous throughput of 18.1 MGD through the PSV upstream of the water reservoir at the BPS. Three pipeline sizes were evaluated, including 24-, 30-, and 36-inch pipe, based on maintaining pressures within an acceptable range of between 35 and 225 psi and at velocities of less than 7 fps.

Table 4-2 summarizes maximum steady state modeled pressures and velocities in the Water Supply Pipeline between the WSPS and BPS for each diameter and demand per route alternative.

Table 4-2 Water Supply Pipeline Size, Water Supply Pumping Station to Booster Pumping Station

Diameter (in)	Velocity (fps)	Maximum Steady State Modeled Pressure per Route Alternative (psi)		
		M1	M2	M3
Minimum Day Demand, 3.1 MGD				
24	1.43	151	156	157
30	0.92	147	153	154
36	0.64	147	152	152
Existing Day Demand, 6.6 MGD				
24	3.05	170	172	175
30	1.96	153	159	159
36	1.36	148	155	155
ADD, 8.2 MGD				
24	3.79	183	183	187
30	2.44	157	162	163
36	1.69	150	156	156
MDD, 13.6 MGD				
24	6.28	254	252	264
30	4.05	178	179	183
36	2.81	158	162	164
WSPS Firm Capacity, 18.1 MGD				
24	8.36	343	339	360
30	5.38	204	202	209
36	3.74	168	170	173

Notes: 1. Cells shaded **red** are greater than the maximum pressure criterion of 225 psi or the maximum velocity criterion of 7 fps.

As shown in **Table 4-2**, Route Alternatives M1, M2, and M3 result in comparable hydraulic conditions. A 24-inch diameter pipeline would produce pressures in excess of the maximum steady state design pressure criterion for demands in excess of the ADD. Therefore, a 24-inch pipeline would be insufficient to serve Waukesha's needs. Both 30- and 36-inch nominal diameter pipelines result in comparable hydraulic conditions with an acceptable range for DIP. A 36-inch nominal diameter pipeline would require a higher capital investment than a 30-inch nominal diameter pipeline.

A 30-inch diameter Water Supply Pipeline between the WSPS and BPS is the preferred size for a pipeline comprised of DIP to satisfy the demand conditions approved by the Compact Council and accommodate the WSPS desired pumping schedule. For the purposes of this Study, Route Alternatives M1, M2, and M3 will be compared with a Water Supply Pipeline diameter of 30-inches between the WSPS and BPS. The pipeline size will be confirmed in the PDR for each preferred pipeline material identified. The maximum pressures will be confirmed in design through transient analysis.

4.3.3.2 Booster Pumping Station to Waukesha Water Utility Distribution System

The InfoWater model described in **Section 4.3.3.1** was configured into an InfoWater model of WWU's distribution system for the purposes of sizing the Water Supply Pipeline between the BPS and WWU's distribution system. The diurnal demand was linearly extrapolated to the demands evaluated across the system. Existing distribution system booster pumps and valves were kept online with logic maintained, while well pumps were turned off. The BPS was simulated by an interim pump curve capable of producing a throughput equivalent to the hourly demand required for the range of heads anticipated from the 1.2 MGD Minimum Day Minimum Hour Demand to the 19.0 MGD PHD. The Minimum Day Minimum Hour Demand utilized Hunter Tower at its minimum level of 26.5 feet and the PHD utilized Hunter Tower at its maximum level of 36.5 feet to represent the full operating range of anticipated heads.

Three pipeline sizes were evaluated, including 24-, 30-, and 36-inch pipe, based on maintaining pressures within an acceptable range of between 35 and 225 psi and at velocities of less than 7 fps. **Table 4-3** summarizes maximum steady state modeled pressures and velocities observed in the Water Supply Pipeline from the BPS to the connection to WWU's distribution system. The head required at the BPS is also shown for each condition, with head presented as the HGL required less the center line of the pumps at the BPS. Note that Route Alternatives M1, M2, and M3 have equivalent hydraulic conditions downstream of the BPS due to their shared routes through the Common Route segment.

Table 4-3 Water Supply Pipeline Size, Booster Pumping Station to Waukesha Water Utility Distribution System

Diameter (in)	Velocity (fps)	Maximum Steady State Modeled Pressure (psi)	BPS Head Required (ft)
Minimum Hour Demand, 1.2 MGD			
24	0.55	114	130
30	0.36	114	130
36	0.25	114	130
Peak Hour Demand, 19.0 MGD			
24	8.77	110	225
30	5.65	115	167
36	3.92	117	151

Notes:

1. Cells shaded red are greater than the maximum pressure criterion of 225 psi or the maximum velocity criterion of 7 fps.

A 24-inch diameter pipeline would result in velocities in excess of 7 fps. Therefore, a 24-inch pipeline is deemed insufficient to serve Waukesha's needs. Both 30- and 36-inch nominal diameter pipelines result in comparable hydraulic conditions with an acceptable range for anticipated flows. A 36-inch nominal diameter pipeline would require a higher capital investment than a 30-inch nominal diameter pipeline. However, the range of heads required by the system curve generated from a 30-inch pipeline is too large for a single set of pumps per available manufacturer pump curves. The BPS would likely require an additional set of pumps to satisfy higher demand conditions, such as the PHD.

For the purposes of this Study, Route Alternatives M1, M2, and M3 will be compared with a Water Supply Pipeline diameter of 36 inches between the BPS and WWU's distribution system. The pipe size will be confirmed in design.

4.3.4 Steady State Hydraulic Conditions

Steady state hydraulic conditions along the water supply system were summarized with HGLs and are presented for each route alternative on **Figure 4-5**. The WSPS was simulated to supply the MDD over an 18-hour pumping schedule and the BPS was paced to meet demand over a 24-hour period. The ground profile has been developed using GIS data and will be updated per the topographic survey data collected during field investigations.

Figure 4-5 has been used to confirm the maximum and minimum steady state pressures anticipated for the Water Supply Pipeline. The pressures are within an acceptable range between 35 and 225 psi and at acceptable velocities below 7 fps.

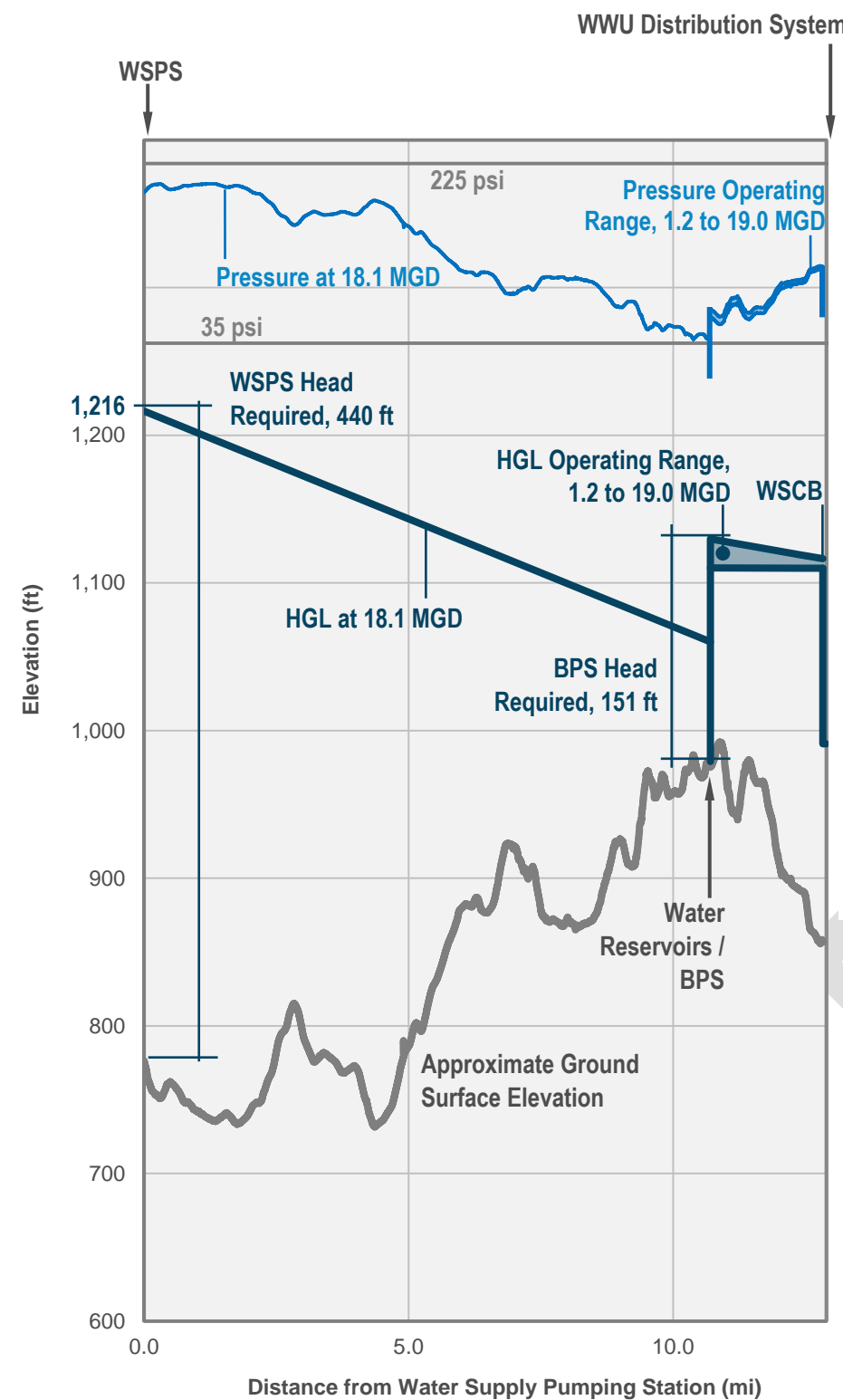
The static head and major friction losses, or head losses due to friction along the pipe wall, have been used to determine the pump head required at the WSPS and BPS, as well as the hydraulic horsepower (hp) based on an 80% combined efficiency for the pumps and pump drives. **Table 4-4** presents a summary of the head and power required for the WSPS and BPS per route alternative.

Table 4-4 Head and Power Required at Pumping Stations for Maximum Day Demand over 18-hour Pumping Schedule

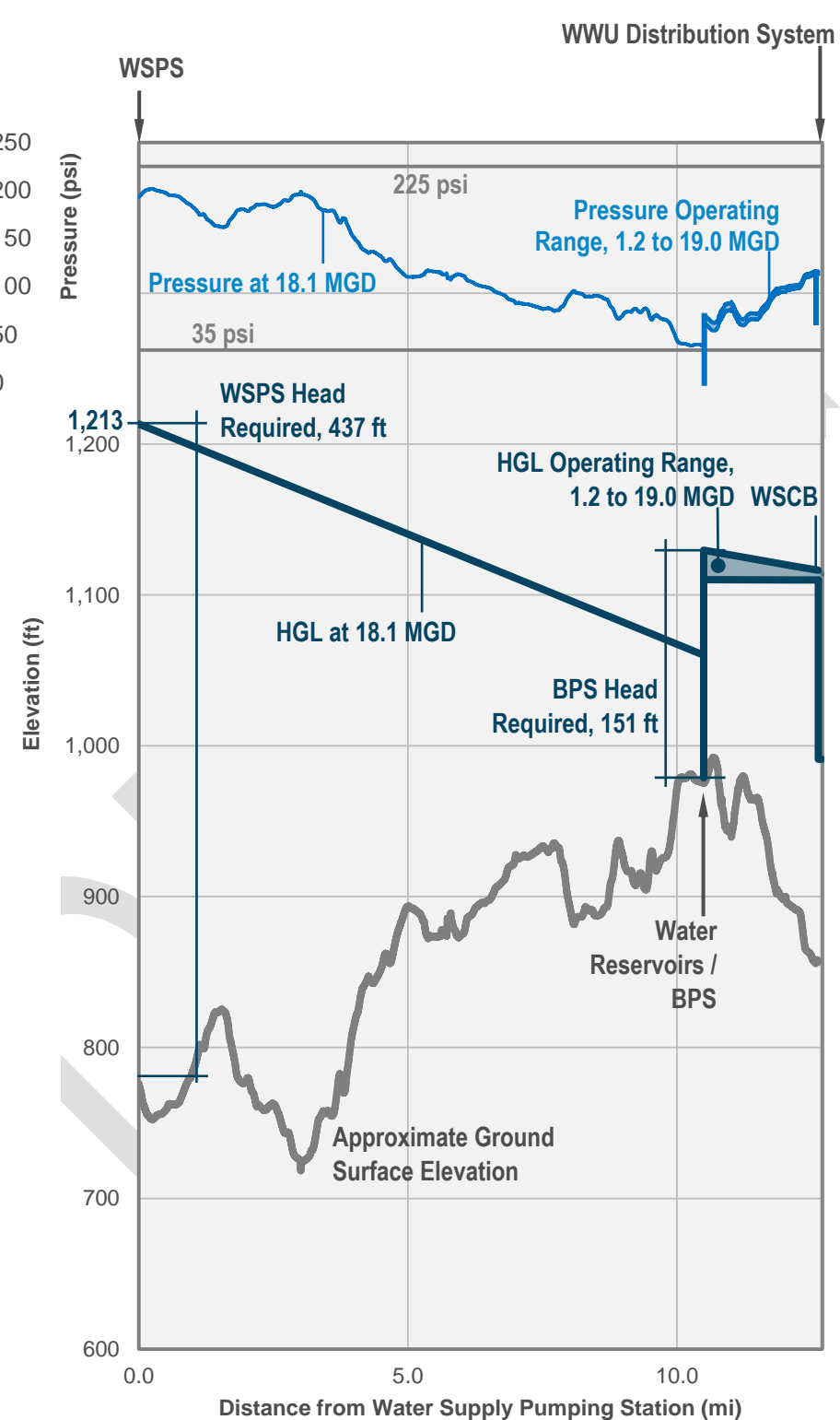
Item	Route Alternative		
	M1	M2	M3
WSPS			
Pressure, psi	190	189	196
Head, feet	440	437	453
Hydraulic Power, hp	1,747	1,735	1,799
Hydraulic Power, kW	1,303	1,294	1,342
BPS			
Pressure, psi	65	65	65
Head, feet	151	151	151
Hydraulic Power, hp	629	629	629
Hydraulic Power, kW	469	469	469

As shown in the table above, each of the route alternatives require similar head and power. Route Alternative M3 requires slightly more head at the WSPS compared to Route Alternatives M1 and M2 because of its greater length of Water Supply Pipeline between the WSPS and BPS. Note that the head and power required at the BPS are equivalent for the route alternatives since all three route alternatives use the Common Route downstream of the BPS.

ROUTE ALTERNATIVE M1



ROUTE ALTERNATIVE M2



ROUTE ALTERNATIVE M3

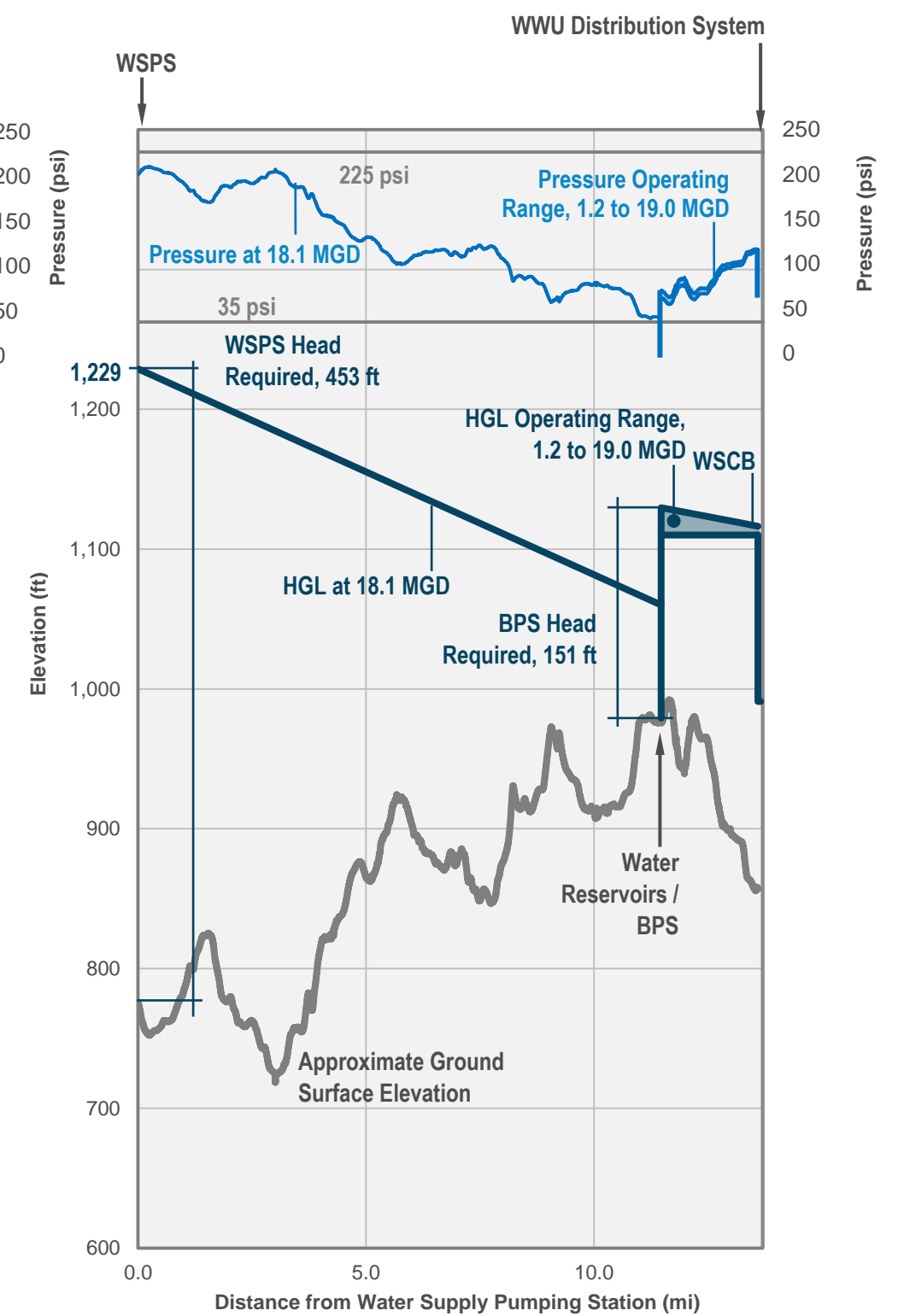


Figure 4-5 Hydraulic Grade Line and Pressure for Water Supply Pipeline

Legend:

- Hydraulic Grade Line (HGL)
- Pressure
- Approximate Ground Surface Elevation

SECTION 5 Evaluation of Route Alternatives M1, M2, and M3

In order to determine a preferred route, Route Alternatives M1, M2, and M3 were evaluated based on an array of economic and non-economic evaluation criteria. The economic and non-economic considerations include the following items in the order they are presented.

Non-economic Evaluation Criteria

- Total pipeline length
- Special crossings
- Geotechnical conditions
- Contaminated materials
- Wetlands
- Waterways
- Endangered resources
- Cultural resources

Economic Evaluation Criteria

- Agricultural resources
- Maintenance of traffic requirements
- Recent and planned regional transportation projects
- Stakeholder feedback
- Real property and easement requirements
- Constructability
- Class 4 opinions of probable construction cost (OPCCs)
- Life cycle pumping costs

These economic and non-economic evaluation criteria were used to evaluate Route Alternatives M1, M2, and M3 and inform route scoring to identify a preferred route as discussed in **Section 6**. The findings presented in this section represent professional judgment based on information available, discussions with WWU, and conditions existing as of the date of this Study. Site visits were conducted to gather visual information along the route alternatives. While field investigations were not conducted, findings from this Study have been used to target field investigations for the preferred route for design. The findings are summarized in the following sections.

5.1 Non-Economic Evaluation

Non-economic evaluation criteria include characteristics or special requirements associated with each route alternative. The non-economic evaluation criteria are based on WWU's sustainability goals and commitment to the community and are aligned with the Envision Rating System for Sustainable Infrastructure. Although not expressed in terms of cost, the non-economic evaluation criteria were used to identify a preferred route.

5.1.1 Total Pipeline Length

The length of the Water Supply Pipeline has a non-economic impact, as additional pipeline length will require more disruption to the public during construction and future required maintenance. Longer pipeline length increases the potential for latent defects (e.g., future leaks) and requires additional pipeline appurtenances that must be maintained. The length of Water Supply Pipeline also has an economic impact, as longer pipeline length will result in a higher capital investment. Longer pipeline lengths will require longer construction durations or additional construction staff to complete construction in the same time frame. Pipeline lengths are summarized in **Table 5-1** per route alternative rounded to the nearest 100 feet and tenth of a mile.

Table 5-1 Total Pipeline Length

Item	Total Pipeline Length for Route Alternatives		
	M1	M2	M3
Water Supply Pipeline (feet [miles])	68,900 [13.0]	67,000 [12.7]	72,100 [13.7]

The values shown include special crossing lengths. The Water Supply Pipeline lengths were developed and measured with desktop resources in GIS software using the North American Datum of 1927 (NAD27). Route Alternative M3 has the longest total pipeline length, approximately 5% and 8% longer than Route Alternatives M1 and M2, respectively. Route Alternative M1 has the second shortest total pipeline length, while Route Alternative M2 has the shortest total pipeline length.

5.1.2 Special Crossings

Special crossings are utilized to cross waterways and minimize traffic disruption where pipelines are anticipated to cross major highways, roads, and railroads. These crossings require coordination with regulating agencies or land owners to obtain permitting and crossing agreements. Fewer special crossings are generally indicative of improved scheduling, less aquatic resources impacts, less risk and less permitting, and, therefore, less cost.

For the purposes of this Study, trenchless crossings were utilized for all special crossings. Trenchless construction can be completed via HDD or the jack and bore method. Anticipated trenchless construction lengths have been quantified during the development of the preliminary horizontal alignments for comparing route alternatives. HDD has been utilized to cross waterways, while the jack and bore method has been used to cross major highways, roads, and railroads. Anticipated trenchless requirement lengths are summarized in **Table 5-2** rounded to the nearest 100 feet and tenth of a mile. As shown, Route Alternative M3 has a longer length of anticipated trenchless requirements than Route Alternatives M1 and M2.

Table 5-2 Special Crossings

Trenchless Construction Method	Special Crossings Total Length per Route Alternative		
	M1	M2	M3
HDD – Water Supply (feet [miles])	3,200 [0.6]	2,900 [0.5]	3,800 [0.7]
Casings – Water Supply (feet [miles])	2,800 [0.5]	2,400 [0.5]	2,600 [0.5]
Total Trenchless	6,000 [1.1]	5,300 [1.0]	6,400 [1.2]

The trenchless crossings and crossing characteristics are summarized in **Table 5-3**, **Table 5-4**, and **Table 5-5** for Route Alternatives M1, M2, and M3, respectively. The tables are organized from the top following the flow path starting at Milwaukee and proceeding along the Water Supply Pipeline to the connection to WWU's distribution system. The tables detail the trenchless crossing method, crossing location, permit requirements, and potential schedule implications. The schedule implications include duration of permit review. Applicable seasonal work constraints for construction were not identified in the permit documentation for special crossings. The WDNR Chapter 30 Permit may require a time of work constraint if construction could impact endangered species habitats. The work conducted as part of this Study has indicated there is low potential for endangered species habitats in proximity to the alignments. These permitting and schedule constraints will continue to be refined in design. The schedule implications will be used to assist in phasing construction to accommodate timing constraints for constructing the crossings, thereby mitigating the risks trenchless requirements cause to construction delays.

Table 5-3, **Table 5-4**, and **Table 5-5** also include references to photographs and panels. Refer to **Appendix A** for photographs collected in proximity to the trenchless crossings included as part of the route description and discussions. Refer to **Appendix I** for panels of the preliminary horizontal alignments that demonstrate the anticipated locations of the trenchless requirements. The panel numbers in **Appendix I** correspond to the numbers provided in **Table 5-3**, **Table 5-4**, and **Table 5-5**.

Table 5-3 Trenchless Crossing Characteristics, Route Alternative M1

Crossing No.	Crossing Method	Panel No.	Photograph No.	Crossing and Location	Required Permits	Schedule Implications
M1-1	HDD	1 of 20	P-3, P-4	Forest Home Avenue at Howard Avenue	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M1-2	Jack and Bore	2 of 20	P-5	Honey Creek Drive at 68th Street	Wisconsin State Right-of-Way Permit	Note 1
M1-3	Jack and Bore	2 of 20	P-8	Morgan Avenue at Honey Creek Drive	Wisconsin State Right-of-Way Permit	Note 1
M1-4	Jack and Bore	3 of 20	P-13	76th Street at Honey Creek Drive	Wisconsin State Right-of-Way Permit	Note 1
M1-5	Jack and Bore	3 of 20	P-11, P-12	Oklahoma Avenue at 76th Street	Wisconsin State Right-of-Way Permit	Note 1
M1-6	Jack and Bore	4 of 20	P-15, P-16	84th Street at Oklahoma Avenue	Wisconsin State Right-of-Way Permit	Note 1
M1-7	Jack and Bore	4 of 20	P-19, P-20	Beloit Road at Oklahoma Avenue	Wisconsin State Right-of-Way Permit	Note 1
M1-8	Jack and Bore	5 of 20	P-21 to P-23	92nd Street at Oklahoma Avenue	Wisconsin State Right-of-Way Permit	Note 1
M1-9	HDD	5 of 20	P-26, P-27	Interstate 41 at Oklahoma Avenue	Wisconsin State Right-of-Way Permit	Note 1
M1-10	Jack and Bore	6 of 20	P-31, P-32	108th Street at Oklahoma Avenue	Wisconsin State Right-of-Way Permit	Note 1
M1-11	Jack and Bore	7 of 20	P-35	Wollmer Road at Oklahoma Avenue	Wisconsin State Right-of-Way Permit	Note 1
M1-12	Jack and Bore	7 of 20	P-36	Oklahoma Avenue near National Avenue	Wisconsin State Right-of-Way Permit, West Allis Street Opening Permit	Note 1
M1-13	HDD	7 of 20	P-37	Root River at Oklahoma Avenue	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M1-14	Jack and Bore	8 of 20	P-40, P-41	Oklahoma Avenue at 124th Street	Wisconsin State Right-of-Way Permit	Note 1
M1-15	HDD	8 of 20	P-45, P-46	Unnamed Waterway at National Avenue	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M1-16	Jack and Bore	9 of 20	P-49, P-50	Sunny Slope Road at National Avenue	Wisconsin State Right-of-Way Permit	Note 1
M1-17	HDD	10 of 20	P-53, P-54	Unnamed Waterway at National Avenue	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M1-18	Jack and Bore	11 of 20	P-58, P-59	Moorland Road at Coffee Road	Wisconsin State Right-of-Way Permit	Note 1
M1-19	Jack and Bore	12/13 of 20	P-68	Calhoun Road at Coffee Road	Wisconsin State Right-of-Way Permit	Note 1
M1-20	HDD	13 of 20	P-69	Unnamed Waterway at Coffee Road	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M1-21	Jack and Bore	17 of 20	P-80 to P-83	Racine Avenue at Swartz Road	Wisconsin State Right-of-Way Permit	Note 1
M1-22	Jack and Bore	20 of 20	P-85 to P-87	Les Paul Parkway at Sunset Drive	Wisconsin State Right-of-Way Permit	Note 1

Notes:

1. For the purposes of this Study, the schedule implications were assumed to be a 30-day permit review period.

Table 5-4 Trenchless Crossing Characteristics, Route Alternative M2

Crossing No.	Crossing Method	Panel No.	Photograph No.	Crossing and Location	Required Permits	Schedule Implications
M2-1	HDD	1 of 19	P-3, P-4	Honey Creek at Forest Home avenue	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M2-2	Jack and Bore	2 of 19	P-6, P-7	68th Street at Forest Home Avenue	Wisconsin State Right-of-Way Permit	Note 1
M2-3	Jack and Bore	2 of 19	P-14	76th Street at Cold Spring Road	Wisconsin State Right-of-Way Permit	Note 1
M2-4	Jack and Bore	3 of 19	P-17, P-18	84th Street at Cold Spring Road	Wisconsin State Right-of-Way Permit	Note 1
M2-5	Jack and Bore	4 of 19	P-24, P-25	92nd Street at Cold Spring Road	Wisconsin State Right-of-Way Permit	Note 1
M2-6	Jack and Bore	5 of 19	P-28	Interstate 41 at Cold Spring Road	Wisconsin State Right-of-Way Permit	Note 1
M2-7	Jack and Bore	5 of 19	P-29	104th Street at Cold Spring Road	Wisconsin State Right-of-Way Permit	Note 1
M2-8	HDD	5 of 19	P-30	Root River at Cold Spring Road	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M2-9	HDD	5/6 of 19	P-33, P-34	Tributary of Root River at Cold Spring Road	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M2-10	HDD	6 of 19	P-38	Unnamed Waterway at Cold Spring Road	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M2-11	Jack and Bore	7 of 19	P-39	Beloit Road at Cold Spring Road	Wisconsin State Right-of-Way Permit	Note 1
M2-12	Jack and Bore	7 of 19	P-42, P-43	124th Street at Cold Spring Road	Wisconsin State Right-of-Way Permit	Note 1
M2-13	Jack and Bore	9 of 19	P-51	Sunny Slope Road at Cold Spring Road	Wisconsin State Right-of-Way Permit	Note 1
M2-14	HDD	9 of 19	-	Unnamed Waterway on Parcel NBC 1241994	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M2-15	Jack and Bore	10 of 19	P-60	Moorland Road at Mayflower Drive	Wisconsin State Right-of-Way Permit	Note 1
M2-16	Jack and Bore	11 of 19	P-66	National Avenue	Wisconsin State Right-of-Way Permit	Note 1
M2-17	Jack and Bore	12 of 19	P-70	Calhoun Road at Observatory Road	Wisconsin State Right-of-Way Permit	Note 1
M2-18	HDD	12 of 19	P-71	Unnamed Waterway at Observatory Road	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M2-19	HDD	13 of 19	P-75	Unnamed Waterway at Observatory Road	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M2-20	Jack and Bore	14 of 19	P-79	Racine Avenue at Observatory Road	Wisconsin State Right-of-Way Permit	Note 1
M2-21	Jack and Bore	19 of 19	P-85 to P-87	Les Paul Parkway at Sunset Drive	Wisconsin State Right-of-Way Permit	Note 1

Notes:

1. For the purposes of this Study, the schedule implications were assumed to be a 30-day permit review period.

Table 5-5 Trenchless Crossing Characteristics, Route Alternative M3

Crossing No.	Crossing Method	Panel No.	Photograph No.	Crossing and Location	Required Permits	Schedule Implications
M3-1	HDD	1 of 22	P-3, P-4	Honey Creek at Forest Home avenue	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M3-2	Jack and Bore	2 of 22	P-6, P-7	68th Street at Forest Home Avenue	Wisconsin State Right-of-Way Permit	Note 1
M3-3	Jack and Bore	2 of 22	P-14	76th Street at Cold Spring Road	Wisconsin State Right-of-Way Permit	Note 1
M3-4	Jack and Bore	3 of 22	P-17, P-18	84th Street at Cold Spring Road	Wisconsin State Right-of-Way Permit	Note 1
M3-5	Jack and Bore	4 of 22	P-24, P-25	92nd Street at Cold Spring Road	Wisconsin State Right-of-Way Permit	Note 1
M3-6	Jack and Bore	5 of 22	P-28	Interstate 41 at Cold Spring Road	Wisconsin State Right-of-Way Permit	Note 1
M3-7	Jack and Bore	5 of 22	P-29	104th Street at Cold Spring Road	Wisconsin State Right-of-Way Permit	Note 1
M3-8	HDD	5 of 22	P-30	Root River at Cold Spring Road	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M3-9	HDD	5/6 of 22	P-33, P-34	Tributary of Root River at Cold Spring Road	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M3-10	HDD	6 of 22	P-38	Unnamed Waterway at Cold Spring Road	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M3-11	Jack and Bore	7 of 22	P-44	124th Street at Beloit Road	Wisconsin State Right-of-Way Permit	Note 1
M3-12	Jack and Bore	8 of 22	P-47	Armour Avenue at Beloit Road	Wisconsin State Right-of-Way Permit	Note 1
M3-13	HDD	8 of 22	P-48	Interstate 43 at Beloit Road	Wisconsin State Right-of-Way Permit	Note 1
M3-14	Jack and Bore	9 of 22	P-52	Sunny Slope Road at Beloit Road	Wisconsin State Right-of-Way Permit	Note 1
M3-15	Jack and Bore	10 of 22	P-57	Interstate 43 at Beloit Road	Wisconsin State Right-of-Way Permit	Note 1
M3-16	Jack and Bore	10 of 22	P-61	Moorland Road at Beloit Road	Wisconsin State Right-of-Way Permit	Note 1
M3-17	HDD	11 of 22	P-62, P-63	Unnamed Waterway at Beloit Road	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M3-18	HDD	12 of 22	P-72	Unnamed Waterway at Beloit Road	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M3-19	Jack and Bore	12 of 22	P-73	Calhoun Road at Beloit Road	Wisconsin State Right-of-Way Permit	Note 1
M3-20	HDD	12 of 22	P-74	Unnamed Waterway at Beloit Road	Wisconsin State Right-of-Way Permit, WDNR Chapter 30 Permit	30-day permit review after submission
M3-21	Jack and Bore	14 of 22	P-76	National Avenue at <u>NBC 1268960</u>	Wisconsin State Right-of-Way Permit	Note 1
M3-22	Jack and Bore	14 of 22	P-77, P-78	Racine Avenue at <u>NBC 1268960</u>	Wisconsin State Right-of-Way Permit	Note 1
M3-23	Jack and Bore	22 of 22	P-85 to P-87	Les Paul Parkway at Sunset Drive	Wisconsin State Right-of-Way Permit	Note 1

Notes:

1. For the purposes of this Study, the schedule implications were assumed to be a 30-day permit review period.

5.1.3 Geotechnical Conditions

Five key considerations have been evaluated to compare route alternatives from a geotechnical perspective. These considerations are:

- Shallow bedrock
- Dense soils
- Organic soils
- Shallow groundwater
- Corrosive environments

The desktop assessment has been conducted to identify the presence of the geotechnical considerations via review of maps, databases, and soil surveys available from the United States Department of Agriculture (USDA) National Resource Conservation Service (NRCS) Web Soil Survey, the Southeastern Wisconsin Regional Planning Commission (SEWRPC), the WisDOT Highway Structures Information System, WDNR Well Construction Reports, and previous geotechnical projects in proximity to route alternatives. The following sections compare route alternatives in terms of these geotechnical considerations.

5.1.3.1 Shallow Bedrock

Shallow bedrock can increase cost and duration of construction. In locations where standard open cut excavation methods and equipment can be utilized, deeper bedrock is generally indicative of lower cost and shorter construction duration, as construction can proceed through loose earthen materials that can be removed quickly with typical excavation equipment.

The bedrock desktop assessment was conducted by reviewing data obtained from the NRCS's online Web Soil Survey tool, as well as a Depth to Bedrock Map provided by SEWRPC. Pipeline corridor lengths were quantified for various depths to bedrock along each of the route alternatives and are summarized to the nearest 100 feet and tenth of a mile in **Table 5-6** and shown on **Figure 5-1** (refer to **Appendix B** for details).

Table 5-6 Shallow Bedrock

Estimated Depth to Bedrock	Estimated Route Alternative Length through Shallow Bedrock		
	M1	M2	M3
<25 feet (feet [miles])	0	0	3,800 [0.7]
25-50 feet (feet [miles])	5,000 [0.9]	9,400 [1.8]	17,800 [3.4]

As shown, Route Alternative M3 has a longer length pipeline through areas with shallower bedrock, while Route Alternative M1 has a shorter length of pipeline through areas with shallower bedrock.

Previous project experience has indicated depth to bedrock is inconsistent with surface topography in Southeast Wisconsin. It is a possibility that bedrock exists at depth intervals other than those indicated by desktop resources. Findings from this Study are being used to develop boring locations. Borings along the preliminary horizontal alignments will confirm bedrock topography in preparation for design.

Plotted: 4/5/2018
Document Path: G:\153 10-Waukesha Great Lakes Water Supply PM-CM\24 GIS\24.05_Working_MXD\Working_Milwaukee_NewPanel1\Bedrock_04052018_Presentation.mxd

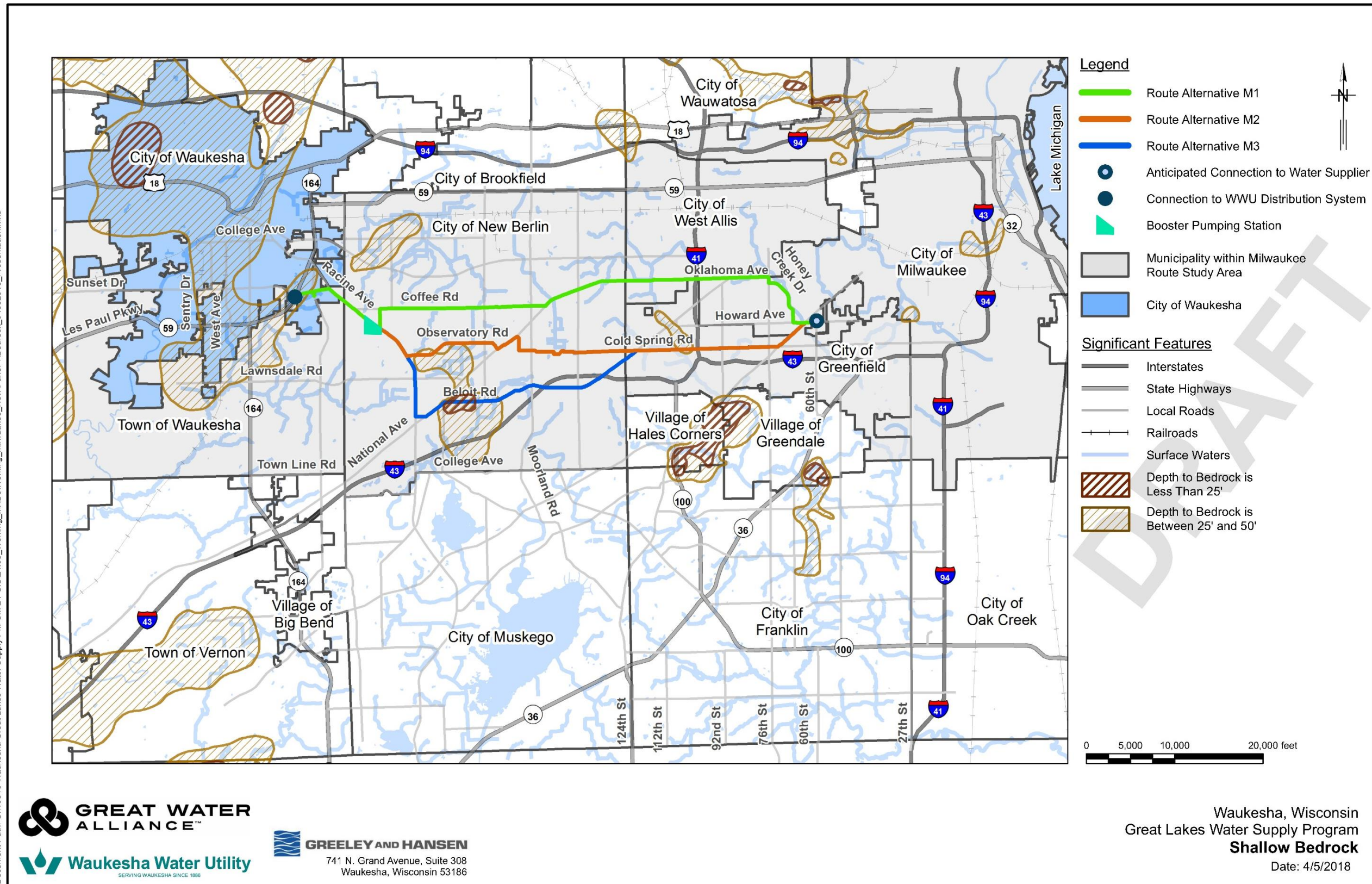


Figure 5-1 Shallow Bedrock

5.1.3.2 Dense Soils

Dense soils are comprised of sand, gravel, and cobbles. Although dense soils can allow for improved stability of trench walls, the presence of cobbles can slow trenchless construction and increase cost and construction duration. The dense soils desktop assessment was conducted by reviewing data obtained from the NRCS's online Web Soil Survey tool. Pipeline corridor lengths were quantified for dense soils along each of the route alternatives and are summarized to the nearest 100 feet and tenth of a mile in **Table 5-7** and shown on **Figure 5-2** (refer to **Appendix B** for details).

Table 5-7 Dense Soils

Geotechnical Study Item	Estimated Route Alternative Length through Dense Soils		
	M1	M2	M3
Dense Soils (feet [miles])	7,800 [1.5]	10,600 [2.0]	18,300 [3.5]

Dense soils are suspected to be encountered in the western portions of the route alternatives near Waukesha and New Berlin for Route Alternatives M1, M2, and M3. In general, dense soils are not anticipated within the eastern portions near Greenfield, Milwaukee, and West Allis. Route Alternative M1 has a shorter length pipeline through areas with anticipated dense soils, while Route Alternative M3 has a longer length of pipeline through areas with anticipated dense soils.

5.1.3.3 Organic Soils

Organic soils, such as peat, include soils with greater than eight percent organic content from plants, animals, or organisms. Organic soils can increase cost and duration of construction. Areas with more organic soils may require deeper excavation for trench stabilization that would otherwise be required. In general, areas near river or creek crossings have increased amounts of organic soils. Since HDD is planned beneath rivers and creeks as discussed in **Section 5.1.2**, HDD installations may be required to be extended past the high organic content soils limits. Less organic soil is generally indicative of lower cost and shorter construction duration due to shallower excavation and shorter lengths for HDD installations.

The organic soils desktop assessment has been conducted by reviewing data obtained from the NRCS's online Web Soil Survey tool. Pipeline corridor lengths were quantified for organic soils along each of the route alternatives and are summarized to the nearest 100 feet and tenth of a mile in **Table 5-8** and shown on **Figure 5-3** (refer to **Appendix B** for details).

Table 5-8 Organic Soils

Geotechnical Study Item	Estimated Route Alternative Length through Organic Soils		
	M1	M2	M3
Organic Soils (feet [miles])	400 [0.1]	0	0

Route Alternatives M2 and M3 are not anticipated to encounter organic soils. Organic soils may exist along Route Alternative M1 beneath Honey Creek Drive. If the Water Supply Pipeline alignment is located within the existing fill embankment, some of these soils may have already been disturbed or replaced during construction activities in this area. Therefore, the organic soils along Route Alternative M1 may not actually exist. From the desktop review, it was determined route alternatives are comparable in terms of organic soils.

Plotted: 4/9/2018
Document Path: \\GH-DATA\01\client\0216310-Waukesha Great Lakes Water Supply PM-CM\24 GIS\24.05_Working_MXD\Working_Milwaukee_New\Geotech\Dense Soils_04052018_Presentation.mxd

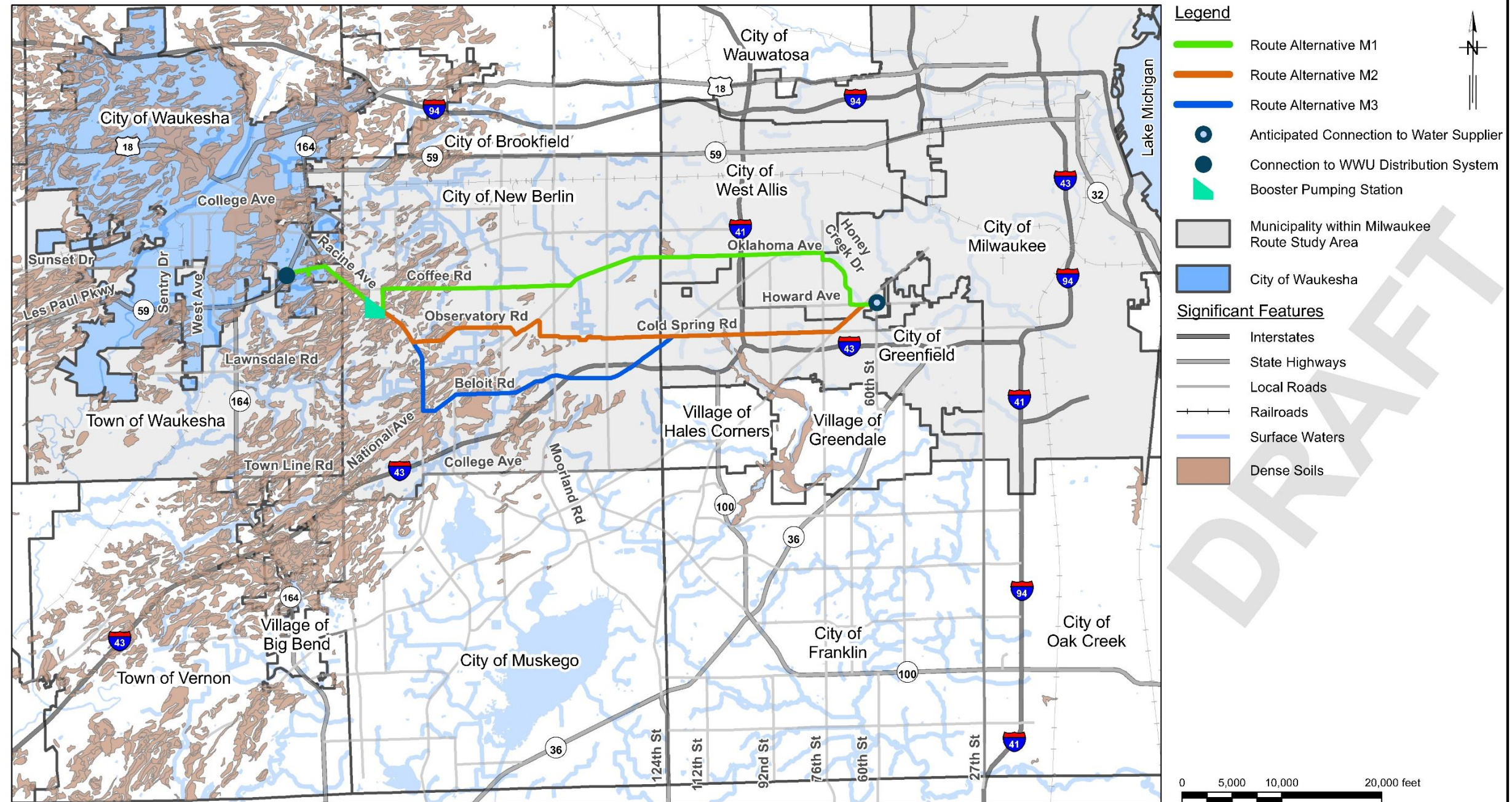


Figure 5-2 Dense Soils

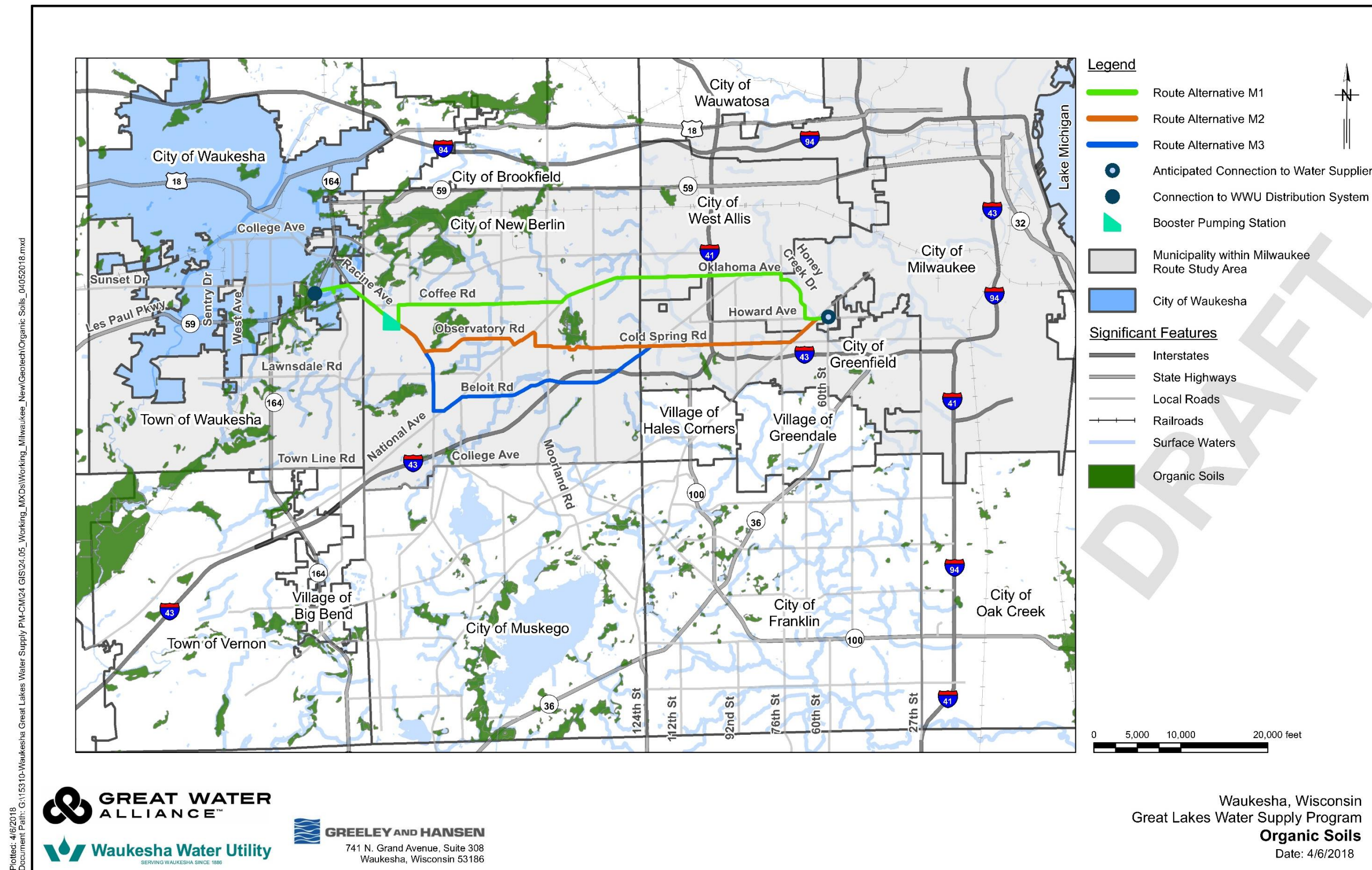


Figure 5-3 Organic Soils

5.1.3.4 Shallow Groundwater

Shallow groundwater has the potential to increase the need for dewatering and general complexity of construction of open cut and trenchless installations, which can increase cost and duration of construction. The shallow groundwater desktop assessment was conducted by reviewing data obtained from the NRCS's online Web Soil Survey tool, as well as a Depth to Groundwater Map provided by SEWRPC. Pipeline corridor lengths were quantified for shallow groundwater along each of the route alternatives and are summarized to the nearest 100 feet and tenth of a mile in **Table 5-9** and shown on **Figure 5-4** (refer to **Appendix B** for details).

Table 5-9 Shallow Groundwater

Geotechnical Study Item	Estimated Route Alternative Length through Shallow Groundwater		
	M1	M2	M3
Total Length Through Shallow Groundwater (0-25 feet in depth) (feet [miles])	30,600 [5.8]	20,600 [3.9]	15,200 [2.9]

All three route alternatives are anticipated to encounter shallow groundwater that will require dewatering. Route Alternative M3 has a shorter length of pipeline through areas with anticipated shallow groundwater, while Route Alternative M1 has a longer length of pipeline through areas with anticipated shallow groundwater, specifically along Coffee Road. Route Alternative M1 will require more dewatering than Route Alternatives M2 and M3.

5.1.3.5 Corrosive Environments

Corrosive soils and stray electrical currents can increase the need for corrosion control in the form of wraps, bonded coatings, and potentially, cathodic protection. The presence of corrosive soils can affect cost and duration of construction. Less corrosive soils are generally indicative of lower cost and shorter construction duration.

The corrosive soils desktop assessment was conducted by reviewing data obtained from the NRCS's online Web Soil Survey tool. Soils have different chemical properties that react differently for DIP and steel pipe than for pre-stressed concrete cylinder pipe (PCCP). Due to the fact that PCCP is not an anticipated material for the Water Supply Pipeline, it was not considered in this evaluation (refer to the PDR for details). Pipeline corridor lengths were quantified for corrosive soils along each of the route alternatives and are summarized to the nearest 100 feet and tenth of a mile in **Table 5-10** and shown on **Figure 5-5** (refer to **Appendix B** for details). Note that **Figure 5-5** does not demonstrate corrosive soils data in Milwaukee. Due to the highly corrosive soils surrounding this area, soils in Milwaukee were assumed to be highly corrosive.

Table 5-10 Corrosive Soils

Geotechnical Study Item	Estimated Route Alternative Length through Corrosive Soils		
	M1	M2	M3
Soils Corrosive to DIP / Steel Pipe (feet [miles])	40,700 [7.7]	48,400 [9.2]	44,700 [8.5]

Route Alternative M1 has a shorter length of pipeline through areas with suspected corrosive soils, while Route Alternative M2 has a longer length of pipeline through areas with anticipated corrosive soils. Borings and laboratory testing of samples collected during field investigations will be used to confirm the presence of corrosive soils and inform the preferred method of corrosion control in design. None of the route alternatives are anticipated to be aligned parallel to or within high voltage electrical transmission utility corridors that could require cathodic protection.

Plotted: 4/9/2018
Document Path: G:\15310-Waukesha Great Lakes Water Supply PM-CM24 GIS\24_05_Working_MXD\Working_Milwaukee_New\Geotech\Depth to Groundwater_04052018.mxd

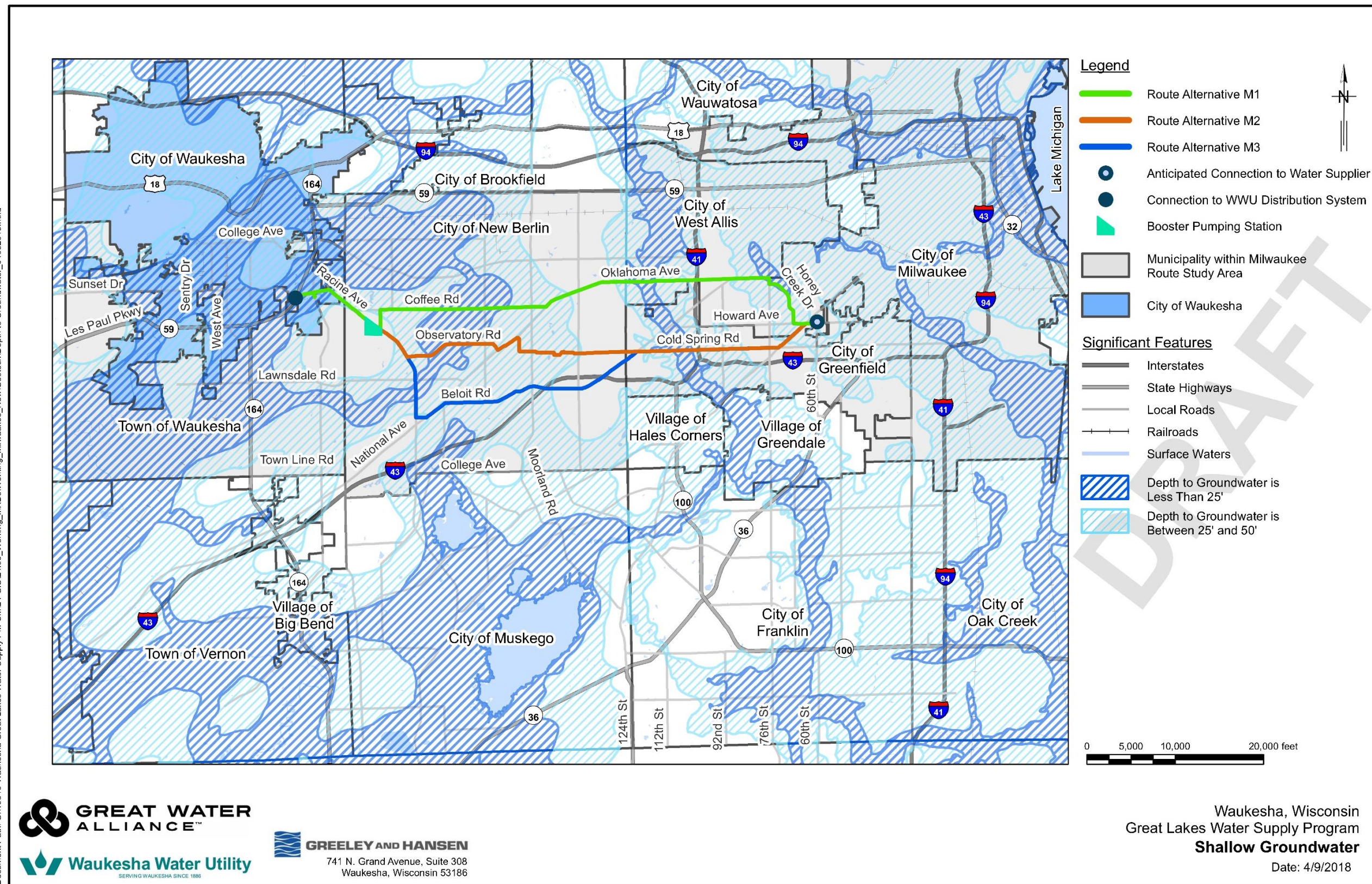


Figure 5-4 Shallow Groundwater

Plotted: 4/9/2018
Document Path: \\GH-DATA\01\client\0216310-Waukesha Great Lakes Water Supply PM-CM\24 GIS\24.05_Working_MXD\Working_Milwaukee_New\Geotech\Corrosive Soils_04052018.mxd

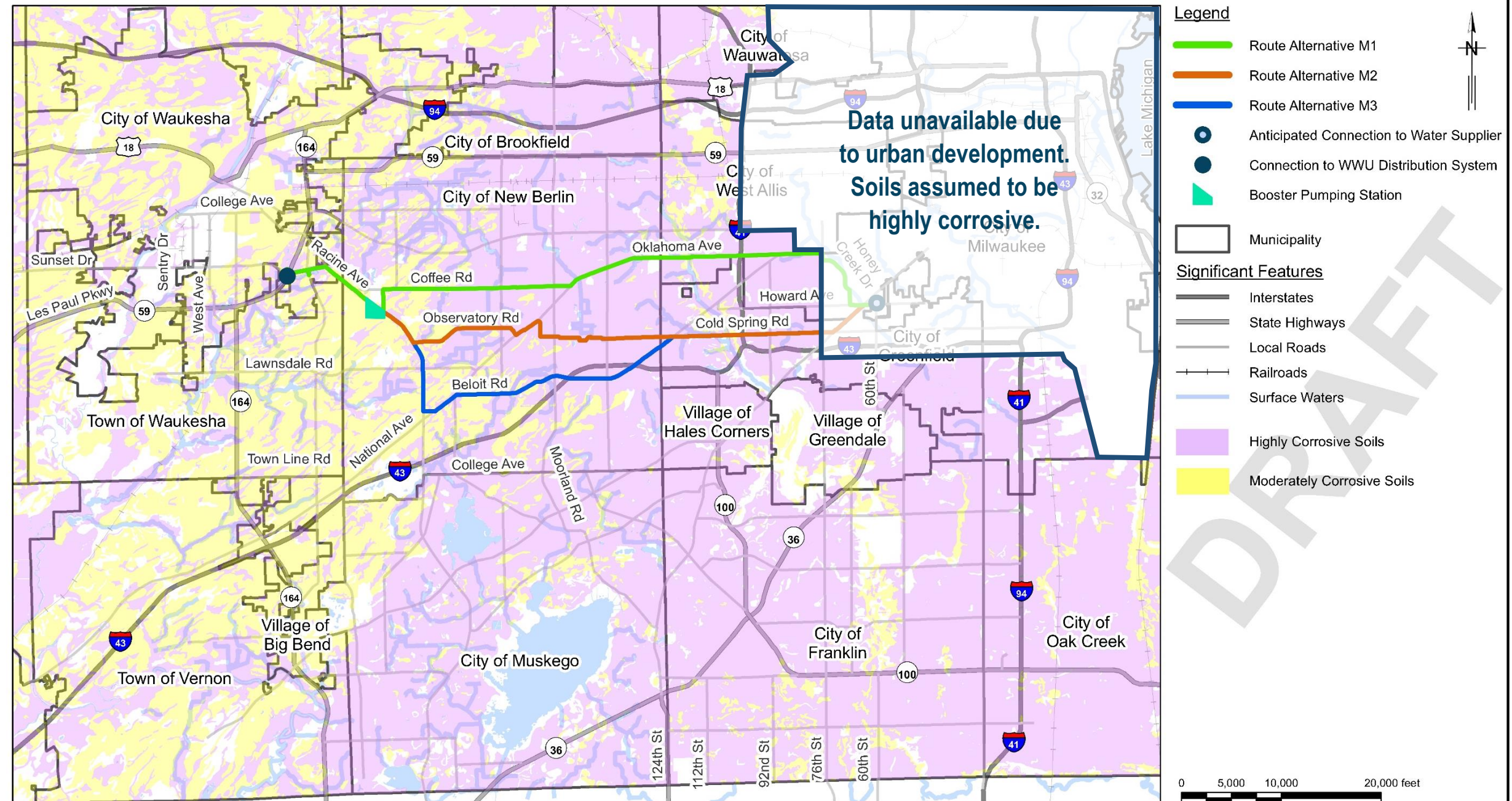


Figure 5-5 Corrosive Soils

5.1.4 Contaminated Materials

Contaminated materials can impact the cost and duration of construction by increasing soil handling time and complexity as well as hauling and disposal requirements. Route alternatives adjacent to fewer contaminated sites have a lower risk of increases to cost, schedule, or permitting attributed to contaminated materials.

Sites that have potential soil and groundwater contamination were identified by review of available online resources utilizing publicly available information and information available through third parties who provide information services regarding environmental issues. Route alternatives were reviewed and individual properties were rated for the potential to encounter contamination in the adjacent right-of-way. A series of database searches were conducted by corridor through review of site identification data provided by Environmental Risk Information Services (ERIS), performing field reconnaissance to more closely observe sites for potential evidence of previously unidentified environmental impacts, assessing historical aerial photographs, reviewing online data provided by the WDNR, and completing review of archived WDNR hard-copy files for sites where online data was not available or not sufficient to evaluate the potential impacts of the site to the Program.

Evaluation of subsurface data was limited to data collected and previously provided to WDNR by others. Since environmental samples have not yet been collected as part of the Program, the length of each route alternative impacted by the potential presence of contamination has not been estimated. As such, route alternatives were evaluated by proximity to contaminated sites documented in desktop resources.

All sites within a one-quarter-mile corridor along each route alternative (or, a one-eighth-mile corridor on either side of each route alternative) as provided by ERIS were evaluated. The corridor width was used to encompass likely contaminated source materials as well as contaminants that may have migrated with groundwater. The resulting list of sites was narrowed to those locations with current or previously identified contamination or suspected solid waste disposal activities.

Sites were ranked relative to a list of standardized criteria developed specifically for this Study. Criteria included consideration of the presence of a confirmed release, the number and source of the releases, the proximity of the release to the right-of-way, the type of contaminant released, documented impacts to the groundwater, and groundwater flow direction as related to the route alternative. The available information was reviewed to determine if non-natural fill materials had been documented or were suspected on the site, if observed site conditions indicated possible poor housekeeping activities or inadequate material storage/handling issues and whether there are any significant information or data gaps.

A potential risk ranking, as referred to as a Site Ranking, was developed for each site based on these criteria. Site Ranking ranged from one to five with five having the highest potential for negative impacts to the route alternatives. In addition, scientific and engineering judgment by engineering and environmental professionals was also applied to each site considering past property uses, unusual or sloppy conditions on the property as well as lack of site-specific information that allowed more certainty in determining the potential hazard level. Additional open impacted sites that were present in the adjacent one-eighth-mile swath on either side of the horizontal alignment were identified and evaluated individually for their potential to require follow-up site investigations despite the distance from the possible pipeline construction areas.

The number of sites along each route alternative was summarized and total rankings were developed to support a comparative evaluation of the route alternatives (refer to **Appendix C** for ranking descriptions and summations). The totaled rankings and the number of sites encountered formed the basis for comparing routes in terms of contaminated materials.

The number of sites by Site Ranking are summarized in **Table 5-11** (refer to **Appendix C** for details).

Table 5-11 Contaminated Materials

Site Ranking (1 = Low Risk, 5 = High Risk)	Estimated Contaminated Material Sites Near Route Alternatives		
	M1	M2	M3
1	39	31	41
2	20	15	14
3	7	8	8
4	11	4	6
5	8	3	4
Total Number of Sites	85	61	73
Total Ranking Score	184	116	137

Route Alternative M1 passes through a more urbanized area that has been developed for industrial and commercial activity since the mid-1900s, as well as an existing landfill located southwest of the intersection of Coffee and Swartz Roads. Route Alternative M2 passes through an area that is predominantly residential with minimal industrial activity. Route Alternative M3 passes through an area that is more rural with less commercial and industrial development. Due to the nature of the development in the area, Route Alternative M1 is in proximity to more suspected contaminated sites than Route Alternatives M2 and M3.

Note that initial review of desktop resources indicate that landfill leachate has not been observed in existing monitoring wells around the landfill. If contaminated materials are encountered, procedures may include using special pipe gaskets to address contaminants from degrading the gaskets, or capturing soils for removal/disposal and replacing them with imported fill material. Field investigations performed during design will confirm the presence of contaminated materials along corridors utilized by the pipeline alignment.

5.1.5 Wetlands

The results of the wetlands evaluation aids in determining the amount and type of wetlands that are anticipated within right-of-way and easements. Fewer wetlands generally result in improved scheduling, less risk, and less permitting.

The desktop wetland assessment was conducted via review of WDNR Wisconsin Wetland Inventory (WWI) mapped wetlands, United States Geological Survey (USGS) topographic maps, NRCS online Web Soil Survey tool, and recent and historical aerial photographs. Mapped and photo-interpreted wetlands were identified on aerial photographs within each corridor associated with route alternatives and within proposed easements.

Although preliminary horizontal alignments were developed to avoid wetlands as part of this Study, the alignments will be further refined due to existing utilities and site constraints in design. Wetland acreages were quantified to include mapped and photo-interpreted wetlands within right-of-way and easements, not just those coinciding with

surface restoration widths centered on preliminary horizontal alignments. Considering that horizontal alignments are subject to further refinement, route alternatives with less acres of mapped and photo-interpreted wetlands within right-of-way and easements have the potential to result in less wetland impacts.

Mapped and photo-interpreted wetland acreages are summarized in **Table 5-12** rounded to the nearest tenth of an acre and shown on **Figure 5-6** (refer to **Appendix D** for details).

Table 5-12 Mapped and Photo-Interpreted Wetlands

Item	Estimated Mapped and Photo-Interpreted Wetland Acreages within Right-of-Way Utilized by Route Alternatives		
	M1	M2	M3
Estimated Total Number of Wetlands	41	72	113
Estimated Wetland Acreage Within Right-of-Way (acres)	2.8	1.6	3.1
Estimated Wetland Acreage Within Easements (acres)	Not applicable	0.1	0.0
Estimated Total Wetland Acreage (acres)	2.8	1.7	3.1

The three route alternatives have mapped and photo-interpreted wetlands within the right-of-way. The values shown in **Table 5-12** are the total estimated amount of wetlands within right-of-way utilized by the route alternatives and, therefore, are greater than the wetland impacts anticipated. Route Alternative M2 traverses corridors with less total estimated wetlands than the other route alternatives, while Route Alternative M3 traverses corridors with more estimated wetlands than the other route alternatives.

The alignments will continue to be refined in design to avoid wetland impacts to the extent feasible.

5.1.6 Waterways

Fewer waterways are generally indicative of less special crossings, which results in lower construction cost, improved scheduling, and less permitting. The desktop waterways assessment was conducted via review of USGS topographic maps, the USGS National Hydrography Dataset (NHD) and recent and historical aerial photographs. Waterway crossings were identified and mapped on recent aerial photographs within right-of-way and easements.

Potential quantities of waterway crossings are summarized in **Table 5-13** and shown on **Figure 5-7** (refer to **Appendix D** for details).

Table 5-13 Waterways

Item	Waterway Crossings for Route Alternatives		
	M1	M2	M3
Number of Waterway Crossings	8	9	8

Route Alternative M2 is anticipated to cross more waterways than Route Alternatives M1 and M3.

Plotted: 4/13/2018
Document Path: G:\15310-Waukesha Great Lakes Water Supply PM-CM24 GIS\24_05_Working_MXD\Working_Milwaukee_NewWetlands_Waterways\Wetlands_04052018.mxd

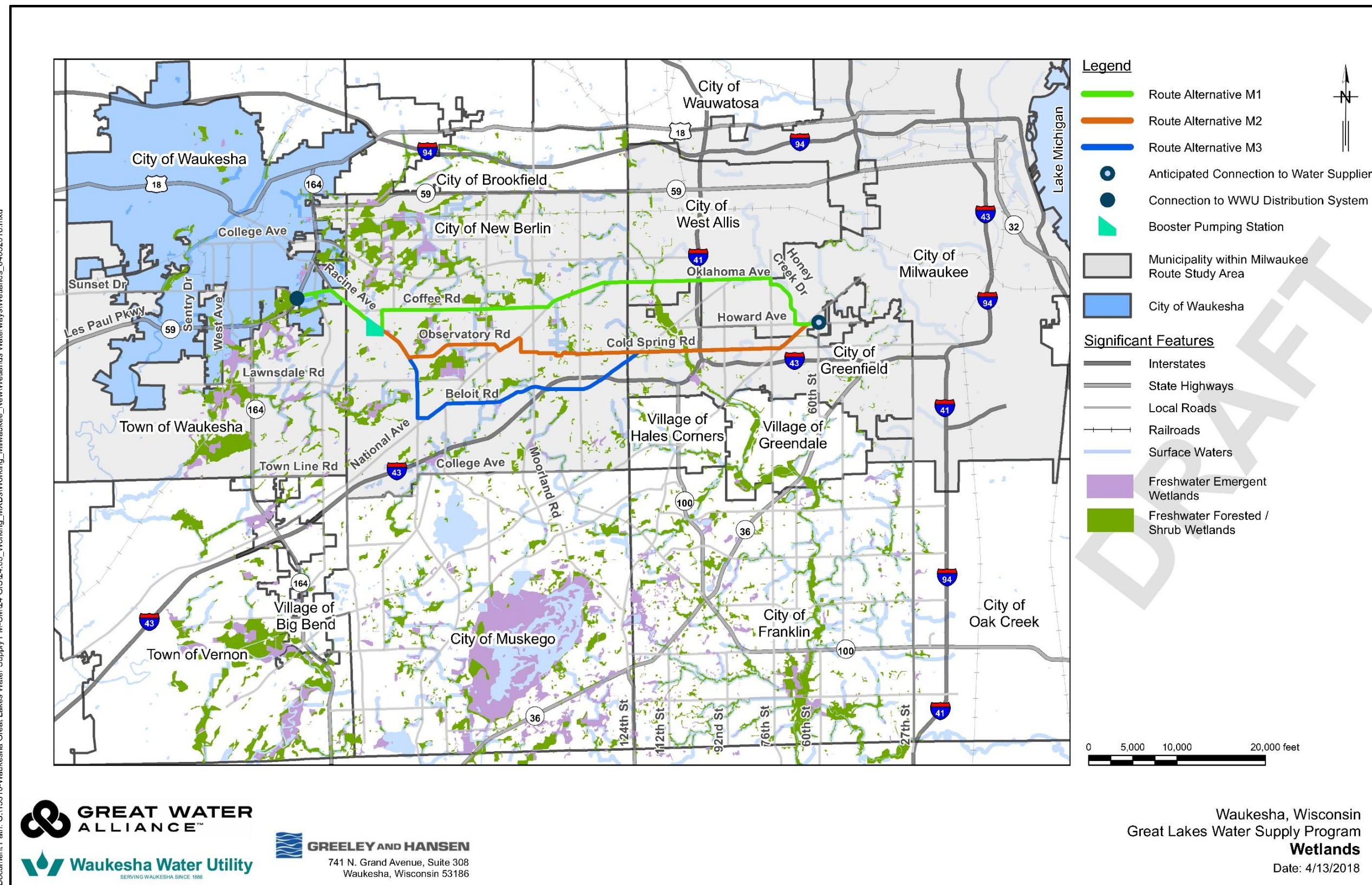


Figure 5-6 Wetlands

Plotted: 4/6/2018
Document Path: G:\15310-Waukesha Great Lakes Water Supply PM-CW24 GIS\24_05_Working_MXD\Working_Milwaukee_NewWetlands_Waterways_04052018.mxd

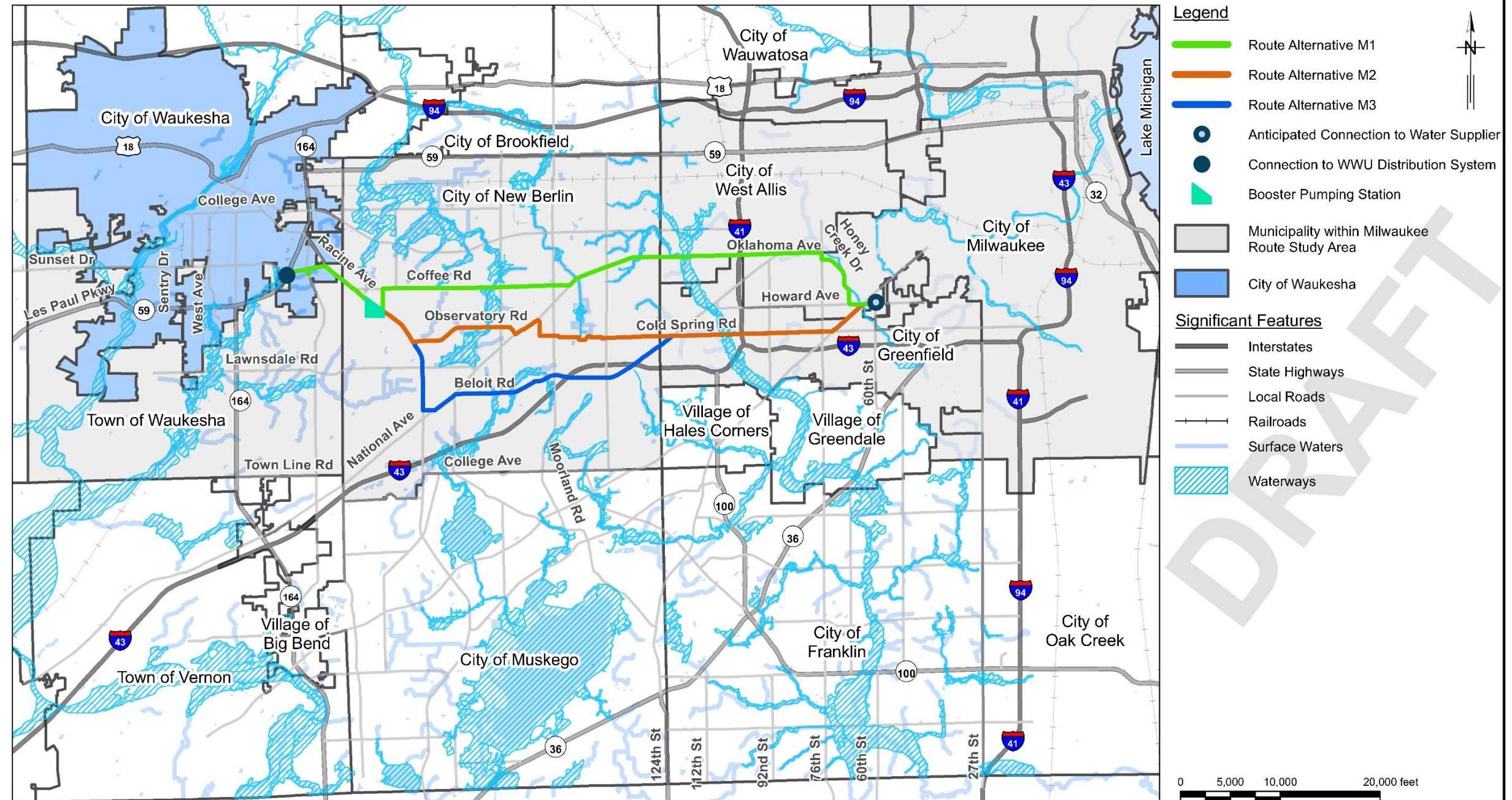


Figure 5-7 Waterways

5.1.7 Endangered Resources

Endangered resources include Rare, Threatened and Endangered (RTE) species that are subject to state and federal regulation under the jurisdiction of the WDNR and U.S. Fish and Wildlife Service (USFWS). Endangered resources can affect the length of construction and permitting effort. Fewer endangered resources result in less risk of schedule delays and less permitting.

The desktop endangered resources assessment was conducted via review of recent and historical aerial photographs, WDNR NHI data and the USFWS Information Planning and Consultation (IPaC) data. The NHI data provided a list of potential RTE species and natural communities, referred to as element occurrences (EOs), which were evaluated to determine required and recommended measures as described below.

- EOs with required measures were assigned for animal species that are state listed as endangered or threatened.
- EOs with recommended measures were assigned for EOs consisting of plants, natural communities, and state special concern animals.
- EOs with no impact were assigned for EOs with lack of suitable habitat or low likelihood of species presence.

Required and recommended measures include time of year restrictions, erosion control, buffers, habitat assessments and surveys, and exclusion fencing. IPaC generated a list of federal threatened and endangered species, critical habitats, migratory birds, federal facilities, and wetlands. High Potential and Low Potential Zones are specific to the Rusty Patched Bumble Bee (RPBB). Low Potential and High Potential Zones were located using publicly available online maps through the USFWS portal. As defined by the USFWS, Low Potential Zones are areas where the RPBB has a low likelihood of species presence, while High Potential Zones are areas where the RPBB is likely to be present. Potential quantities of state EOs, federal RTE species, and USFWS High and Low Potential Zones are summarized in **Table 5-14** for each route alternative (refer to **Appendix E** for details).

Table 5-14 Endangered Resources

Item	Estimated Endangered Resources Near Route Alternatives		
	M1	M2	M3
EOs with Required Measures	0	0	0
EOs with Recommended Measures	4	5	4
EOs with No Impact	8	3	3
Federal RTE Species	3	3	3
USFWS RPBB Low Potential Zone	Yes	Yes	Yes
USFWS RPBB High Potential Zone	No	No	No

Route Alternatives M1, M2, and M3 have the same three federal RTE species in proximity to its alignment, which include the Poweshiek skipperling, northern long-eared bat, and the eastern prairie-fringed orchid. All three route alternatives are located within a Low Potential Zone near Milwaukee and Waukesha Counties in which the RPBB has a low likelihood of species presence. Route Alternatives M1 and M3 have the same number of EOs with recommended measures in proximity to their alignments, while Route Alternative M2 has an additional EO with recommended measures in proximity to its alignment. None of the route alternatives have EOs with required measures or are located within a High Potential Zone in which the RPBB has a high likelihood of species presence.

5.1.8 Cultural Resources

Cultural resources include significant or sensitive archaeological and architectural sites and can affect construction duration and permitting effort. Fewer cultural resources result in less risk of construction delays and less permitting. Cultural resources will require an archaeological survey along the preferred route to comply with the National Historic Preservation Act.

Literature and archives research included the Wisconsin Historic Preservation Database (WHPD), the Archaeological Report Inventory (ARI), the Archaeological Site Inventory (ASI), the Architecture History Inventory (AHI), the C.E. Brown Atlas, the C.E. Brown Manuscripts, county historical society publications, county site files, 1937-38 aerial photographs, historical topographic maps, the General Land Office (GLO) survey maps, the Wisconsin Land Economic Inventory (WLEI) maps, the National Register of Historic Places (NRHP), and public and university library documents. Some cultural resources, including archaeological and burial sites, have been historically identified as generally located within the parcel the resource was originally found. Since initial identification, parcel borders and right-of-way lines may have changed.

The estimated number of cultural resources that are within 100 feet of right-of-way and easements are summarized in **Table 5-15** and cultural resources in Waukesha and Milwaukee Counties are shown on **Figure 5-8** (refer to **Appendix F** for details).

Table 5-15 Cultural Resources

Item	Estimated Cultural Resources Near Route Alternatives		
	M1	M2	M3
Archaeological Sites	0	0	1
Burial Sites	2	2	3
Historic Structures ¹	0	0	1
NRHP Listed Sites	0	0	0

Notes:

1. Historic Structures include those along corridors utilized by route alternatives, and not within the 100-foot buffer.

Route Alternative M3 is in proximity to more suspected cultural resources, while Route Alternatives M1 and M2 are in proximity to fewer suspected cultural resources. Route Alternatives M1 and M2 are not located in proximity to any archaeological or NRHP listed sites within 100 feet of the right-of-way and proposed easements.

5.1.9 Agricultural Resources

An agricultural resources impact assessment is a key item required by the PSC and the Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP) in a construction project and as part of the Certificate of Public Convenience and Necessity (CPCN) process. The assessment is comprised of the anticipated impacts to agricultural resources, where fewer impacts are more preferable. For compliance with DATCP, the Program will be submitting an Agricultural Impact Notice to DATCP to provide information for the Agricultural Impact Statement.

The agricultural resources desktop assessment was conducted via review of locations of agricultural lands, quantity of agricultural lands and types of agricultural lands using the Waukesha County Open Data Portal Website, Milwaukee County Land Information Office Geospatial data, the USDA Organic Integrity Database and the Organic Agriculture in Wisconsin 2017 Status Report and 2015 Status Report.

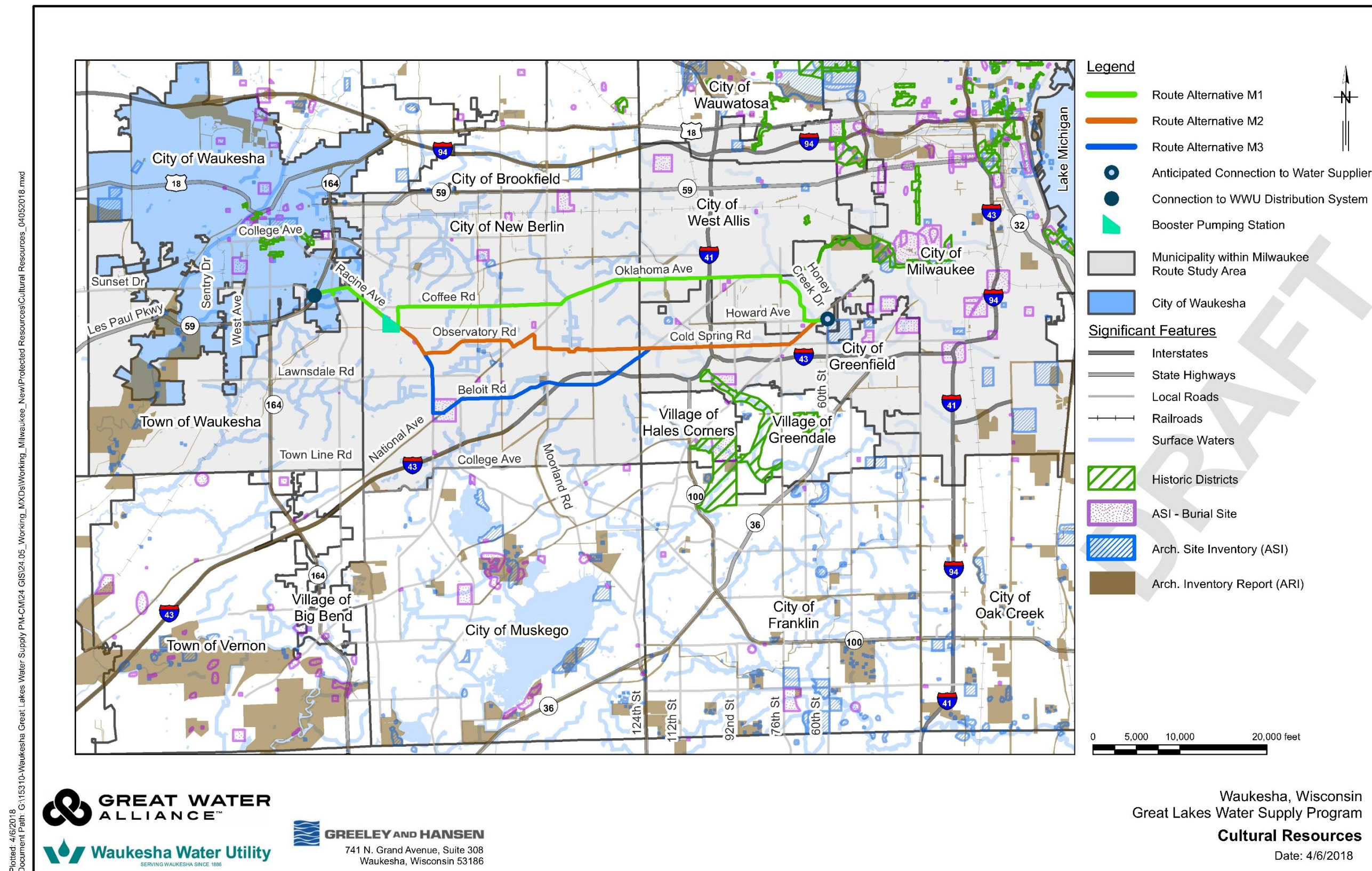


Figure 5-8 Cultural Resources

A summary of acreages of anticipated agricultural resource impacts are summarized to the nearest tenth of an acre in **Table 5-16** (refer to **Appendix G** for details).

Table 5-16 Agricultural Resources

Item	Estimated Agricultural Resources Near Route Alternatives		
	M1	M2	M3
Certified Organic Farms	0	0	0
Easements (acres)	0.0	0.0	0.0

None of the route alternatives are in corridors in proximity of certified organic farms, and none of the route alternatives are anticipated to have easements through agricultural lands. Therefore, route alternatives are comparable in terms of agricultural resources.

5.1.10 Maintenance of Traffic Requirements

Route alternatives are proposed to be installed within the existing right-of-way for the majority of their alignments. Therefore, construction of the pipeline along the preferred route will impact traffic. Impacts on local traffic will affect the public's perception of the Program during and after construction.

A Maintenance of Traffic Plan will be required to present a safe and effective way to move vehicular and pedestrian traffic during construction. The plan will need to identify construction phasing to maintain ingress and egress to existing property owners and businesses, and detour plans. A preliminary maintenance of traffic strategy is discussed in **Appendix A** in the description and discussion of route alternatives. This section focuses on comparing route alternatives with respect to travel detours anticipated per route alternative.

To compare route alternatives in terms of maintenance of traffic requirements, the routes were separated into four elements – the Common Route (containing corridors with all three route alternatives), as well as portions of Route Alternatives M1, M2, and M3 that are not part of the Common Route. A field evaluation was conducted to assess existing pavement conditions. Roadway classification, number of through lanes, location of turn lanes and ADT data have been collected for each roadway along each route alternative. Potential traffic impacts were identified and traffic detours mapped on recent aerial photographs. The impacts were segregated into two main categories – roadway impacts and traffic impacts. Road impacts from construction activities considered roadways, sidewalks, and paths. Assumptions were made for roadway and traffic impacts, as summarized below.

- **Road Impacts**
 - Pipeline alignments will be located along the centerline of the road. The assumption that the alignment follows the centerline of the road is more conservative than the preliminary horizontal alignments that show the pipelines beyond the edge of pavement. The preliminary horizontal alignment is subject to refinement in design based on utility coordination and field investigations.
 - Construction will require a 12-foot wide excavator in line with each trench.
 - Construction will require a 10-foot wide dump truck.
 - Construction will require a two-foot width of traffic barrels.
- **Traffic Impacts**
 - Collectors, minor arterials, and principal arterials will have greater amounts of traffic and warrant detours.

- Roads will be detoured to other roadways with at least the same classification as the road requiring a detour.
- Local roads will have small amounts of traffic and will not require detours as they serve familiar drivers.
- Flagger operation locations have not been specifically identified, though they will be required in areas where local road access must be maintained.

Utilizing the assumptions listed above, the total roadway length (rounded to the nearest tenth of a mile), pavement area (rounded to the nearest 100 square feet), additional traffic distance (rounded to the nearest 100 miles), and total lost time from travel detours (rounded to the nearest 100 hours) are summarized in **Table 5-17** (refer to **Appendix H** for details). In **Table 5-17**, the “Total Additional Travel Distance from Detours” was calculated by using the ADT per road closed, amount of days per road closure, and total distance of the detour. The “Total Lost Travel Time from Detours” was calculated by using the ADT per road closure, amount of days per road closure, and added travel time per detour.

Table 5-17 Transportation

Item	Common Route	Route Alternative		
		M1	M2	M3
Estimated Total Roadway Length (miles)	2.5	10.5	10.1	11.3
Estimated Total Roadway Pavement Area (square feet)	24,100	527,300	453,000	393,700
Estimated Total Additional Travel Distance from Detours (miles)	0	121,800	316,500	1,758,800
Estimated Total Lost Travel Time from Detours (hours)	0	5,700	57,900	76,400

All route alternatives impact traffic, but the extent of the potential traffic impacts vary amongst route alternatives. Route Alternative M1 is anticipated to cause much less lost travel time, specifically an order of magnitude fewer traffic detour hours than Route Alternatives M2 and M3. In addition, Route Alternative M1 is anticipated to require fewer additional driving miles than Route Alternatives M2 and M3. The more preferable maintenance of traffic anticipated for Route Alternative M1 is attributed to its route through wider corridors, where longer detours to other corridors would likely be limited. Thus, Route Alternative M1 is more preferable than Route Alternatives M2 and M3 in terms of maintenance of traffic.

5.1.11 Recent and Planned Regional Transportation Projects

Regional transportation projects recently completed or planned by local municipalities or transportation authorities before and during construction may affect the phasing and schedule of Program construction. Recently completed or planned regional transportation projects that are anticipated before Program construction that overlap with corridors utilized by route alternatives can affect Program schedule, cost, and permitting. Additional risks include added costs and schedule delays that may arise if the planned regional transportation project is delayed.

In the cases where the planned regional transportation project overlaps with route alternative corridors, the pipeline design may require adjustment to minimize or avoid conflicts such that rebuilding of new infrastructure is minimized or eliminated. Where regional transportation projects are planned during Program construction that overlap with route alternatives, opportunities may exist to take advantage of potential synergies, such as sharing maintenance of traffic and surface restoration costs between the two projects.

Projects and improvements are planned in corridors coinciding with route alternatives. Information about these projects were obtained from capital improvement plans and meetings with local municipalities and county and state

departments of transportation. A summary of recently completed, permitted, or scheduled construction projects is shown in **Table 5-18**.

Table 5-18 Recent and Planned Regional Transportation Projects

Anticipated Year of Construction	Route Alternative Length through Recent or Planned Regional Transportation Projects		
	M1	M2	M3
2017 (feet [miles])	0	0	9,900 [1.9]
2018 (feet [miles])	0	0	0
2019 (feet [miles])	0	0	0
2020 (feet [miles])	0	0	0
Total Before Construction (feet [miles])	0	0	9,900 [1.9]
2021 (feet [miles])	0	0	0
Total During Construction (feet [miles])	0	0	0

Route Alternatives M1 and M2 do not have any identified recently completed or planned regional transportation projects parallel to their routes. Route Alternative M3 overlaps with one project that was completed in 2017 along Beloit Road in New Berlin. The project included a 1.8-mile road construction and resurfacing project on Beloit Road from National Avenue to Moorland Road. Modifications to preliminary horizontal alignments and/or trenchless construction methods may be considered in design if feasible to reduce the need to rebuild segments of the road.

Coordination with local municipalities and transportation agencies will continue to occur throughout design in preparation for construction.

5.1.12 Stakeholder Feedback

Stakeholders include residents and businesses in the respective municipalities that the route alternatives travel through. Stakeholder feedback is an important consideration that considers public perception in proximity to the route alignments. Stakeholder feedback can identify areas where further route refinement is necessary. Three Open House Meetings were held on February 12, 14, and 15, 2018 in West Allis, Greenfield, and New Berlin, respectively. An Open House Meeting for Milwaukee was held on April 4, 2018. Open House Meetings are utilized to acquire stakeholder feedback in the communities that the Water Supply Pipeline could be located. Stakeholder feedback received on each route alternative by Open House attendees are summarized below.

- **Route Alternative M1:**
 - Route Alternative M1 appears to be a more direct route than the other alternatives.
 - Coffee Road is a newer road and the public was concerned whether Route Alternative M1 would impact the road.
 - Some residents noted that Coffee Road has had some drainage issues east of Swartz Road.
- **Route Alternative M2:**
 - Route Alternative M2 includes narrower corridors with more residential areas, including Cold Spring Road and corridors just west of Eisenhower Middle/High School.
- **Route Alternative M3:**
 - Route Alternative M3 is longer and, therefore, would be suspected to have greater public impacts.

- Route Alternative M3 includes some narrow corridors in residential areas, including Cold Spring Road and Observatory Road.
- Segments of Beloit Road were improved in 2017 and stakeholders were concerned whether the route would impact the new road.

Responses with respect to some of the stakeholder feedback concerns noted above were provided as follows.

- **Route Alternative M1:**
 - Since Coffee Road is a wider corridor, there is potential to reduce impacts by maintaining a pipeline alignment beyond the edge of pavement (refer to **Appendix I** that demonstrates the preliminary horizontal alignment of the Water Supply Pipeline beyond the edge of pavement of Coffee Road).
 - Surface restoration will consider proper stormwater drainage per applicable standards during design.
- **Route Alternative M2:**
 - None
- **Route Alternative M3:**
 - Recently improved segments along Beloit Road are unavoidable and would be impacted for Route Alternative M3 (refer to **Section 5.1.11** and **Appendix I** for Route Alternative M3's preliminary horizontal alignment).

Route Alternatives M2 and M3 have more stakeholder concerns than Route Alternative M1. The most commonly expressed stakeholder concern focused on routes through residential areas. Route Alternatives M2 and M3 are aligned through narrower and more residential corridors where more stakeholder challenges are anticipated. Route Alternative M1 is anticipated to require fewer driving hours and less travel distance due to detours than Route Alternatives M2 and M3. Stakeholder challenges affect the Program's public perception and could also result in additional cost due to rerouting of the pipeline, schedule impacts, and/or litigation fees. Therefore, the fewer stakeholder challenges anticipated for Route Alternative M1 is beneficial to the Program.

5.1.13 Real Property and Easement Requirements

The majority of Route Alternatives M1, M2, and M3 are within right-of-way. However, Route Alternatives M2 and M3 exit the right-of-way and enter private property, which will require easement acquisitions within private property. There are added risks for Program costs and scheduling in cases where the property owner opposes an easement. In these instances, the pipeline may need to be rerouted.

The required permanent easements are anticipated to be 50 feet wide. The number and acreage of permanent easements required for each route alternative is summarized in **Table 5-19**. Route Alternatives M1, M2, and M3 right-of-way and ownership is summarized per the flow path in **Table 5-20** through **Table 5-22**, while easement requirements are summarized per route alternative in **Table 5-23**.

Table 5-19 Real Property and Easement Requirements

Item	Route Alternative		
	M1	M2	M3
Number of Easements	0	1	1
Acreage of Easements	0.0	2.9	0.9

Table 5-20 Right-of-Way and Ownership, Route Alternative M1

Segment	From	To	Owned By
Howard Avenue	60th Street	68th Street	Greenfield/Milwaukee
68th Street	Howard Avenue	Honey Creek Drive	Milwaukee
Honey Creek Drive	68th Street	76th Street	Milwaukee
76th Street	Honey Creek Drive	Oklahoma Avenue	Milwaukee County
Oklahoma Avenue	76th Street	National Avenue	Milwaukee County
Oklahoma Avenue	National Avenue	124th Street	West Allis
Oklahoma Avenue	124th Street	132nd Street	Waukesha County
National Avenue	132nd Street	Coffee Road	Waukesha County
Coffee Road	National Avenue	Swartz Road	New Berlin
Swartz Road	Coffee Road	Racine Avenue	New Berlin
Racine Avenue	Swartz Road	Sunset Drive	Waukesha County
Sunset Drive	Racine Avenue	Les Paul Parkway	Waukesha

Table 5-21 Right-of-Way and Ownership, Route Alternative M2

Segment	From	To	Owned By
Howard Avenue	60th Street	Forest Home Avenue	Greenfield/Milwaukee
Forest Home Avenue	Howard Avenue	Cold Spring Road	State of Wisconsin
Cold Spring Road	Forest Home Avenue	124th Street	Greenfield
Cold Spring Road	124th Street	<u>NBC 1241994</u>	New Berlin
Fenway Drive	<u>NBC 1241994</u>	Regal Drive	New Berlin
Regal Drive	Fenway Drive	Fenway Drive	New Berlin
Fenway Drive	Regal Drive	Mayflower Drive	New Berlin
Mayflower Drive	Fenway Drive	Church Drive	New Berlin
Church Drive	Mayflower Drive	National Avenue	New Berlin
National Avenue	Church Drive	Observatory Road	Waukesha County
Observatory Road	National Avenue	Racine Avenue	New Berlin
Racine Avenue	Observatory Road	Sunset Drive	Waukesha County
Sunset Drive	Racine Avenue	Les Paul Parkway	Waukesha

Notes: 1. Private property parcels are shown in underlined text.

Table 5-22 Right-of-Way and Ownership, Route Alternative M3

Segment	From	To	Owned By
Howard Avenue	60th Street	Forest Home Avenue	Greenfield/Milwaukee
Forest Home Avenue	Howard Avenue	Cold Spring Road	State of Wisconsin
Cold Spring Road	Forest Home Avenue	Beloit Road	Greenfield
Beloit Road	Cold Spring Road	124th Street	Milwaukee County
Beloit Road	124th Street	National Avenue	Waukesha County
National Avenue	Beloit Road	<u>NBC 1269960</u>	Waukesha County
Racine Avenue	<u>NBC 1269960</u>	Sunset Drive	Waukesha County
Sunset Drive	Racine Avenue	Les Paul Parkway	Waukesha

Notes: 1. Private property parcels are shown in underlined text.

Table 5-23 Easement Requirements, Route Alternatives M2 and M3

Route Alternative	Tax Key	From	To	Owned By
M2	<u>NBC 1241994</u>	Sunny Slope Road	Fenway Drive	New Berlin Public Schools
M3	<u>NBC 1268960</u>	National Avenue	Racine Avenue	Prospect Hills II LLC

Notes: 1. Private property parcels are shown in underlined text.

As shown in in **Table 5-19** through **Table 5-23**, Route Alternative M1 does not require any easements, while Route Alternatives M2 and M3 each require easements. Route Alternatives M2 and M3 will incur additional costs to acquire easements.

5.1.14 Constructability

Throughout Route Alternatives M1, M2, and M3 there may be specific areas in which construction activities would be impeded by existing conditions. The areas of concern within route alternatives may lengthen construction duration and cost for that specific area. Areas of concern have been identified utilizing desktop evaluation with available aerial photography and field reconnaissance as areas with heavy vegetation, steep ditches, urban areas, undeveloped areas, and narrow corridors. Constructability concerns are summarized below:

- **Heavy vegetation** in proximity to the route alignment will require increased site work including clearing and grubbing, as well as the potential for medium-sized tree removal. Construction in these areas may require additional permitting associated with construction through wetlands or construction requiring tree removal. Heavy vegetation will also create difficulty for general site access and mobility for large construction equipment. Heavy vegetation may also limit the areas in which construction equipment and materials may be staged. In areas close to the edge of the right-of-way, overhanging trees or vegetation may create concern for potential damage to vegetation that is on private property. Depending on the requirements per municipality and private parcels, there may be an increased need for replacing removed surface materials, such as landscaping, in-kind.
- **Steep ditches** on the side of roads may create difficulty for access and increased caution for mobility on the work site. Areas with steep ditches may require an increased need for site development such as grade

changes and construction access points. Steep ditches may also limit the amount and location of construction access points for large equipment and materials.

- **Urban areas** with increased density of industrial, commercial, and residential areas will increase the general complexity of construction phasing. To minimize effects on the public, industrial, commercial, and residential locations will require access. This access may lengthen duration of construction activities, depending on what level of access is required and when access is required. Increased densities of industrial, commercial, and residential areas will increase complexity of maintenance of traffic, reduce mobility of equipment, slow production of construction, and require additional site security measures. Heavily developed areas will also increase design and construction effort to minimize conflicts with existing utilities. Urban areas would also increase the requirements for pavement removal and replacement.
- **Undeveloped areas** will require a means of access to allow for large construction equipment and materials to be transported to the construction site and to operate on the construction site. Permanent access roads may be required to access pipeline appurtenances if the pipelines are beyond right-of-way.
- **Narrow corridors** in which the right-of-way and construction area is limited in dimension will increase the effort required for equipment mobility and material staging. This increased effort could slow production during construction increase the duration of construction activities within narrow corridors.

Route alternatives have been evaluated in terms of constructability. In terms of urban and undeveloped areas, all three route alternatives traverse more urban areas east of Interstate 41, and progressively more rural areas as the routes proceed west of Calhoun Road towards the BPS. Thus, route alternatives are comparable in terms of urban and undeveloped areas.

Route Alternative M2 has the most constructability challenges primarily due to heavy vegetation, steep ditches, and narrow corridors. The primary corridors with these attributes are Cold Spring Road west of Interstate 41, Fenway Drive, Mayflower Drive, Church Drive, and Observatory Road. These segments include narrow corridors that are flanked with dense trees and overhead tree canopies along some segments, as well as overhead electrical utilities. The nature of the urban development along these corridors has the potential for sanitary sewers and laterals that may need to be relocated or require the pipeline to be installed deeper. Observatory Road also contains multiple segments with steep ditches beyond the narrow road. Production through these corridors are anticipated to be slower than those anticipated in wider corridors where there is more room for construction operation.

Relative to Route Alternative M2, Route Alternative M3 reduces the constructability challenges related to narrow corridors and overhead trees and electrical utilities by utilizing Beloit Road west of its intersection with Cold Spring Road. This route avoids construction along Cold Spring Road west of Beloit Road, as well as the narrow, more residential corridors of Fenway, Mayflower, and Church Drives. However, Route Alternative M3 is still routed through Cold Spring Road east of Beloit Road, which is still a narrower corridor with multiple segments flanked with dense trees, overhead tree canopies, and electrical utilities. Route Alternative M3 is routed through areas along Beloit Road with a depth to bedrock suspected shallower than 25 feet, which could impact open cut and trenchless construction.

Route Alternative M1 has the potential to minimize constructability challenges relative to Route Alternatives M2 and M3 due to its alignment along Oklahoma Avenue and Coffee Road that eliminates pipeline length along narrow, residential corridors with overhead trees and electrical utilities. There is less potential for utility conflicts along Route Alternative M1 and more potential for the pipeline to be installed shallower. Production during construction in these corridors are anticipated to be greater than those in Route Alternatives M2 and M3 due to the additional space available for operating construction equipment and staging of materials. From the constructability review, Route Alternative M1 has the potential to have fewer constructability challenges relative to the other alternatives.

5.1.15 Non-Economic Evaluation

The non-economic evaluations described in **Section 5** are summarized in **Table 5-24**. Red circles indicate that a route alternative is less preferable and green circles indicate a route alternative is more preferable. Orange circles indicate that a route alternative is at an intermediate level between preferable and not preferable.

Table 5-24 Non-Economic Evaluations Summary

Non-Economic Evaluation Criteria	Route Alternative		
	M1	M2	M3
Total Pipeline Length	●	●	●
Special Crossings	●	●	●
Shallow Bedrock	●	●	●
Dense Soils	●	●	●
Organic Soils	●	●	●
Shallow Groundwater	●	●	●
Corrosive Soils	●	●	●
Contaminated Materials	●	●	●
Wetlands	●	●	●
Waterways	●	●	●
Endangered Resources	●	●	●
Cultural Resources	●	●	●
Agricultural Resources	●	●	●
Maintenance of Traffic Requirements	●	●	●
Recent and Planned Regional Transportation Projects	●	●	●
Stakeholder Feedback	●	●	●
Real Property and Easement Requirements	●	●	●
Constructability	●	●	●

Non-economic evaluation criteria and route scores were reviewed in the Route Study Meeting: Preliminary Preferred Water Supply Route (4-100 M-05) held with WWU on February 16, 2018 and the Route Study Meeting: Preferred Water Supply Route (4-100 M-06) held with WWU on April 6, 2018. Considering the non-economic criteria, Route Alternative M1 is more preferable than Route Alternatives M2 and M3.

5.2 Economic Evaluation

The economic evaluation criteria include the capital and life cycle costs required for the Water Supply Pipeline and Appurtenances of the three route alternatives in order to implement Waukesha's new water supply in a cost-effective manner.

5.2.1 Opinions of Probable Construction Cost

Class 4 OPCCs were prepared in accordance with the Association for the Advancement of Cost Engineering's (AACE's) Recommended Practice No. 18R-97 to provide a means for comparing route alternatives on an economic basis. Class 4 OPCCs are typically prepared for alternatives analyses, to confirm economic or technical feasibility, to pursue budget approval necessary to proceed to the next phase of a project, or during detailed strategic planning.

The Class 4 OPCC is generally developed during conceptual design or preliminary engineering using capacity factors, parametric models, and engineering judgement.

Thirteen key Program Elements associated with the construction of Program infrastructure were identified. These Program Elements were presented as part of the Phase 1 High-Level Cost Validation Workshop (Phase 1, W-05) held with WWU on November 10, 2016. The Program Elements were also provided as part of the High-Level Program Cost Evaluation Memorandum.

- | | |
|--|--|
| 1. Water Connection at Water Supplier | 8. WWU Distribution System Improvements |
| 2. Water Supply Pumping Station | 9. Return Flow Pumping Station |
| 3. Water Supply Pipeline and Appurtenances | 10. Return Flow Pipeline and Appurtenances |
| 4. Water Reservoirs | 11. Return Flow Discharge Facilities at Root River |
| 5. Booster Pumping Station | 12. Necessary CWP Improvements (Exclusive of RFPS) |
| 6. Chemical Feed Facilities | 13. Other Program Elements |
| 7. Water Connection to Waukesha | |

For the purposes of this Study, focus has been placed on the Program Element with differing costs for comparing route alternatives – Program Element No. 3 – Water Supply Pipeline and Appurtenances. Class 4 OPCCs were prepared in accordance with the Association for the Advancement of Cost Engineering's (AACE's) Recommended Practice No. 18R-97. A Class 4 OPCC per AACE standards is typically used for project screening, determination of feasibility, and concept evaluation. Costs were developed at an Engineering News-Record Construction Cost Indices (ENR CCI) value of 10,942 with a contingency of 25%, bonds and insurance (at 3%), mobilization and demobilization (at 5%), and contractor overhead and profit (at 15%). Costs have been developed to reflect differences in urban and rural construction and construction beneath pavement and landscaped areas per the typical sections shown on **Figure 2-5** through **Figure 2-7**.

The Class 4 OPCCs for Program Element No. 3 for each route alternative are summarized in **Table 5-25** rounded to the nearest tenth of a million dollars. Class 4 OPCCs for Route Alternatives M1 and M2 are also shown relative the OPCC for Route Alternative M3, as previous planning efforts for the Program have considered a route similar to Route Alternative M3.

Table 5-25 Class 4 Opinions of Probable Construction Cost for Route Alternatives

Item	Class 4 OPCCs for Route Alternatives (June 2017 ENR CCI = 10,942)		
	M1	M2	M3
Class 4 OPCCs ¹ (\$-Million)	63.2	64.6	69.5
Class 4 OPCC Comparison (\$-Million)	-6.3	-4.9	0.0

Notes: 1. Class OPCCs include Program Element No. 3 – Water Supply Pipeline and Appurtenances.

The Class 4 OPCCs were discussed as part of the Route Study Meeting: Preliminary Preferred Water Supply Route (4-100 M-05) held with WWU on February 16, 2018 and the Route Study Meeting: Preferred Water Supply Route (4-100 M-06) held with WWU on April 6, 2018. As shown in **Table 5-25**, the Class 4 OPCC for Route Alternative M1 is less than the other route alternatives.

It was determined that the Class 4 OPCCs for Route Alternatives M2 and M3 have risks of increasing due to potential relocation of additional utilities in narrower corridors, as well as additional surface restoration that may be required,

such as impacted trees in proximity to residents. Additional pipeline length that may also be required along Route Alternative M2 if the easement through Eisenhower Middle/High School is not able to be acquired.

5.2.2 Life Cycle Pumping Costs

Energy will be required to convey water between Milwaukee and Waukesha. Higher energy consumption due to pumping is associated with increased life cycle costs. Energy consumption is directly related to the total head required to pump water as evaluated in **Section 4.3.4**. The total heads required at the WSPS and BPS were used to calculate the annualized cost and 20-year life cycle cost for pumping water along the water supply system.

The life cycle pumping costs for Route Alternatives M1, M2, and M3 are summarized in **Table 5-26** rounded to the nearest hundredth of a million dollars.

Table 5-26 Life Cycle Pumping Costs

Life Cycle Pumping Costs ¹	Estimated Life Cycle Pumping Costs for Route Alternatives		
	M1	M2	M3
Annualized Life Cycle Cost (\$-Million)	0.53	0.53	0.55
20-Year Life Cycle Cost (\$-Million)	10.56	10.59	10.98

Notes:

1. Life cycle pumping costs are based on an 8.2 MGD ADD conveyed at a throughput equivalent to the firm capacity of each pumping station. Costs include a \$0.075/kWhr electrical rate, a 3.00% inflation rate, and an 8.00% discount rate.

Route Alternatives M1 and M2 have comparable life cycle pumping costs to convey flow along the water supply system, while Route Alternative M3 requires more due to additional major friction losses anticipated across a longer pipeline length.

SECTION 6 Preferred Route

Route Alternatives M1, M2, and M3 were evaluated to identify a preferred route for the Water Supply Pipeline from Milwaukee to Waukesha. The evaluation process was guided by the Envision Rating System for Sustainable Infrastructure. This evaluation was a comprehensive impact assessment that assigned a score to each of the three route alternatives based on economic and non-economic criteria. The method and results for scoring route alternatives are described in the following sections and the preferred route is identified.

6.1 Development of Key Performance Indicators

Key Performance Indicators (KPIs) were developed to integrate WWU's vision for their new water supply system into the design process and provide a basis for developing metrics to evaluate and compare route alternatives. KPIs are criteria that remain constant with constant weights, while the route alternatives and the metrics for each KPI change based on the decision that is being evaluated. Although they are not all assigned a cost value, the KPIs are of critical importance in determining the preferred route that considers both economic and non-economic evaluation criteria.

An initial list of KPIs were developed and shared with WWU as part of the Preliminary Route Alternatives Report Workshop (4-100 W-01) held on February 2, 2017. The KPI definitions were developed to be broad enough to apply to all aspects of the Program and act as universal weighing criteria. WWU staff weighted the KPIs from one (to represent a KPI of less importance) to ten (to represent a KPI of greater importance) to allow the evaluation to consider WWU preferences. The KPI weightings and feedback were reviewed with WWU during the Route Study – Alternative Routes Review Meeting (4-100 M-01) held on March 2, 2017. The KPIs were subsequently adjusted to reflect input from WWU and all of the weights were linearly scaled such that the sum of all weights produced a sum of 100.

The KPIs are listed by descending weight in **Table 6-1** alongside their definition using language from the Envision Rating System for Sustainable Infrastructure. The updated list of KPIs and their definitions were agreed to by WWU during the Route Meeting: Ryan Road Sub-Alternatives and Criteria Weighting with Envision (4-100 M-02) held on May 18, 2017.

Table 6-1 Key Performance Indicator Summary

Key Performance Indicator	Definition	Weighting
System Reliability	Using robust design strategies, preventive maintenance and intuitive configurations, Program Elements are dependable and resilient.	19
Life Cycle Cost	Pursue strategies that reduce long-term operational and maintenance costs.	15.5
Schedule	Complete the Program in a timeframe that mitigates negative impacts on the affected communities' quality of life.	14
Ease of Construction	Avoid sites that require intensive efforts to preserve or restore existing environmental conditions and utilities, integrate infrastructure, or access with construction equipment.	11
Public Acceptability	The Program vision and goals align with those of the affected communities, and the implementation of the Program expands the skills, capacity, mobility, and health of a community while mitigating negative impacts.	6.5
Capital Cost	Minimize financial impact on the affected communities with consideration of factors such as resource conservation, ease of infrastructure integration, and avoiding site development that requires additional efforts to preserve existing site conditions.	6
Effects on Ability to Finance	Through triple bottom line (TBL) analysis of social, economic, and environmental impacts, Program Elements have been mitigated for risk and resiliency, helping enhance support for infrastructure investment.	6

Key Performance Indicator	Definition	Weighting
Future Expansion	Implement designs and other measures that allow for the expansion of the Program to incorporate Compact Council approved future connections and increased flow without requiring additional infrastructure and capital expenditure.	6
Operational Flexibility	Reduce vulnerabilities by creating an adaptable design that can function in a variety of social, economic, and environmental conditions with monitored systems that allow ease and consistency of operation.	6
Environmental Impact	Measures are taken to preserve the natural world through avoidance, monitoring, restoration, and negative impact mitigation; resources are conserved during the construction and operation of the Program; there is a concerted effort to preserve the ambient conditions that affect quality of life of the affected communities, such as noise, light, air quality, wetlands, and waterways.	5
Cost Sharing Potential	Thorough infrastructure integration and commitment to synergistic opportunities, the cost of Program Elements is potentially shared by a broader community.	5

Data and information from the economic and non-economic evaluation presented in **Section 5** were used to develop metrics for the KPIs. These metrics, in conjunction with input and feedback obtained during Open House Meetings with stakeholders, were quantified as metrics and assigned to corresponding KPIs. **Table 6-2** displays the metrics selected and the KPIs to which they were assigned.

Table 6-2 Metrics Delineated into Key Performance Indicators

Key Performance Indicator	Metrics (Units)
System Reliability	Total Pipeline Length (feet of pipeline), Accessibility (i.e., Special Crossings [no. of special crossings], Real Property and Easement Requirements [no. of easements]), Maximum Pressure Entering the Distribution System (psi)
Life Cycle Cost	Class 4 OPCC (U.S. Dollars), Life Cycle Pumping Cost (U.S. Dollars)
Schedule	Days (Determined by feet of pipeline / day and the anticipated duration of permit approvals)
Ease of Construction	Depth to Bedrock (estimated feet of pipeline < 50 feet deep), Dense Soils (estimated feet of pipeline), Organic Soils (estimated feet of pipeline), Shallow Groundwater (estimated feet of pipeline), Corrosive Environments (estimated feet of pipeline in soils corrosive to DIP / steel pipe), Contaminated Materials (Total Ranking Score)
Public Acceptability	Cultural Resources (estimated no. of sites), Transportation (feet of roadway impacts, square feet of pavement area, additional driving hours), Real Property and Easement Requirements (no. of easements), Agriculture Resources (estimated acres), Recent and Planned Regional Transportation Projects (feet of pipeline), Stakeholder Feedback
Capital Cost	Class 4 OPCC (U.S. Dollars)
Effects on Ability to Finance	Net TBL Score
Future Expansion	Number of Municipalities Traversed, Total Average Day Demand of Municipalities Traversed (MGD) ¹
Operational Flexibility	Number of Valves, Number of Connections to the Distribution System, Distribution System Pressure (psi)
Environmental Impact	Wetlands (estimated acres of mapped and photo-interpreted wetlands), Waterways (no. of waterway crossings)
Cost Sharing Potential	Number of Municipalities Traversed, Planned Regional Transportation Projects (during Program construction)

Notes:

1. Future expansion of WWU's distribution system or other municipalities along the pipeline would need to be approved by the Compact Council.

6.2 Route Alternatives M1, M2, and M3 Scoring

Route Alternatives M1, M2, and M3 were scored on a scale from one (to represent a less favorable alternative for the established KPI) to five (to represent a more favorable alternative for the established KPI) based on their performance for each metric. These scores were entered into the Triple Bottom Line (TBL) matrix as shown in **Table**

6-3. The TBL evaluation incorporates three dimensions of performance – Social and Community, Economic, and Environmental. The KPIs were assigned into the dimensions of performance to which they best corresponded. The scores of each of the route alternatives in the TBL evaluation are displayed at the bottom of the matrix where a higher score indicates a more preferable route alternative.

Table 6-3 Triple Bottom Line Evaluation for the Route Alternatives M1, M2, and M3

Criteria	Weighting ¹	Maximum Possible Score	Route Alternative		
			M1	M2	M3
1 Social and Community Goals					
1.1 Schedule	14.0	5	3	2	2
1.2 Public Acceptability	6.5	5	5	2	3
1.3 Operational Flexibility	6.0	5	3	3	3
1.4 Future Expansion	6.0	5	3	3	4
2 Economic Goals					
2.1 System Reliability	19.0	5	3	3	3
2.2 Life Cycle Cost	15.5	5	3	3	2
2.3 Ease of Construction	11.0	5	4	2	3
2.4 Capital Cost	6.0	5	3	3	2
2.5 Effects on Ability to Finance	6.0	5	4	2	3
2.6 Cost Sharing Potential	5.0	5	3	3	4
3 Environmental Goals					
3.1 Environmental Impact	5.0	5	3	3	3
Net TBL Score²	100	500	330	263	276
Percent of Max Possible Score			66%	53%	55%

¹ Weighting = Relative Importance Category Weight as Percent of Total of All Categories x Sub-criteria Internal Weighting Factor as Percent of Criteria Total x Sum of Criteria Total (For Sub-criteria 1.1 = 0.20 x 0.40 x 100 = 8.0)

² Net TBL Score = Sum of sub-criteria score x Weighting for each Alternative. Net TBL Scores were rounded to nearest whole number.

The highest-weighted KPIs are System Reliability, Life Cycle Cost, Schedule, and Ease of Construction. Route Alternatives M1, M2, and M3 scored the same with respect to the highest-weighted KPI, System Reliability. Route Alternatives M1 and M2 scored the same in the second highest-weighted KPI, Life Cycle Cost. Route Alternative M2, however, scored less preferably than Route Alternative M1 in the third highest-weighted KPI, Schedule. Route Alternative M2 also scored less preferably than other two route alternatives in the fourth highest-weighted KPI, Ease of Construction, as well as in Public Acceptability and Effects on Ability to Finance. The low scoring of Route Alternative M2 is principally attributed to anticipated stakeholder challenges and constructability through more narrow, residential corridors. These corridors would also require additional maintenance of traffic in terms of driving hours and driving distance, and has the most easement requirements of any of the route alternatives. Furthermore, Route Alternative M2 has a higher Class 4 OPCC than Route Alternative M1 and several considerations could further increase the cost associated with Route Alternative M2 due to the potential for additional pipeline length if the required easement is not able to be acquired, as well as additional surface restoration or utility relocation. Many of these factors also pose risks to slowing production during construction. Considering economic and non-economic factors, Route Alternative M2 is less preferable than Route Alternatives M1 and M3.

Although Route Alternative M3 scored more preferably than Route Alternative M2, Route Alternative M3 has a higher Class 4 OPCC than the other two route alternatives due to its longer pipeline length and special crossing requirements. Route Alternative M3's length along areas of suspected shallow bedrock also poses a risk to further increasing capital costs. Route Alternative M3 scored less preferably than the other two route alternatives in the second highest-weighted KPI, Life Cycle Cost, due to additional anticipated energy costs attributed to pumping water along a longer pipeline length. Although Route Alternative M3 avoids the use of narrow corridors west of Beloit Avenue, it still utilizes Cold Spring Road east of Beloit Avenue that requires additional maintenance of traffic

requirements, as well as anticipated stakeholder and constructability challenges through more narrow corridors. If either Route Alternative M2 or M3 utilized the High Voltage Electrical Transmission Utility Corridor between Forest Home Avenue and 94th Street (i.e., Route Sub-Alternative M2-1.4 on **Figure 3-6**), Route Alternatives M2 and M3 would still be have higher Class 4 OPCCs and require more travel time and distance due to maintenance of traffic than Route Alternative M1.

Route Alternative M1 reduces the challenges associated with Route Alternatives M2 and M3 by routing through the Oklahoma Avenue and Coffee Road, which are wider corridors with lower densities of residential areas. This improves constructability, reduces maintenance of traffic requirements, and reduces risks of higher costs associated with additional utility relocation in space-constrained areas and surface restoration. Many of these factors support a faster rate of production during construction for Route Alternative M1 than the other route alternatives. Route Alternative M1 requires no easements, and traverses no near-term planned regional transportation projects. The route alternative is also anticipated to have less public impacts and stakeholder challenges than the other route alternatives.

Route scores were shared with WWU during the Route Study Meeting: Preliminary Preferred Water Supply Route (4-100 M-05) held on February 16, 2018 and the Route Study Meeting: Preferred Water Supply Route (4-100 M-06) held with WWU on April 6, 2018. Considering economic and non-economic evaluation criteria, Route Alternative M1 is the preferred route to supply Waukesha with a new, sustainable water supply from Milwaukee.

For the purposes of this Study, the WSPS and connection point to MWW's distribution system were located near the intersection of 60th Street and Howard Avenue. Discussions with representatives from MWW revealed the locations were not anticipated to change the preferred route identified in this Study. As of the date of this Study, the WSPS is anticipated to be located on the southwest quadrant of 68th Street and Morgan Avenue, while the connection point to the MWW distribution system is anticipated to be located near the intersection of 60th Street and Morgan Avenue. These locations shorten Route Alternative M1 by 2,400 feet and reduce its Class 4 OPCC by approximately \$1.9M. Likewise, the locations lengthen Route Alternatives M2 and M3 by 3,700 feet, while increasing their Class 4 OPCCs by \$2.5M. The anticipated locations of the WSPS and connection point to MWW's distribution system have not changed the preferred route identified in this Study and only serve to make the preferred route more preferable.

The preferred route, Route Alternative M1, is shown on **Figure 6-1**. The preferred route is shown for a connection point to the MWW distribution system at 60th Street and Morgan Avenue and the WSPS at 68th Street and Morgan Avenue. The Water Supply Pipeline with this configuration will also be reflected in the PDR.

Document Path: \\GH-DATA\01\client\0215310-Waukesha Great Lakes Water Supply PM-CM\24 GIS\24.05_Working_MXD\Working_Milwaukee_NewPreferred Route_03222018.mxd

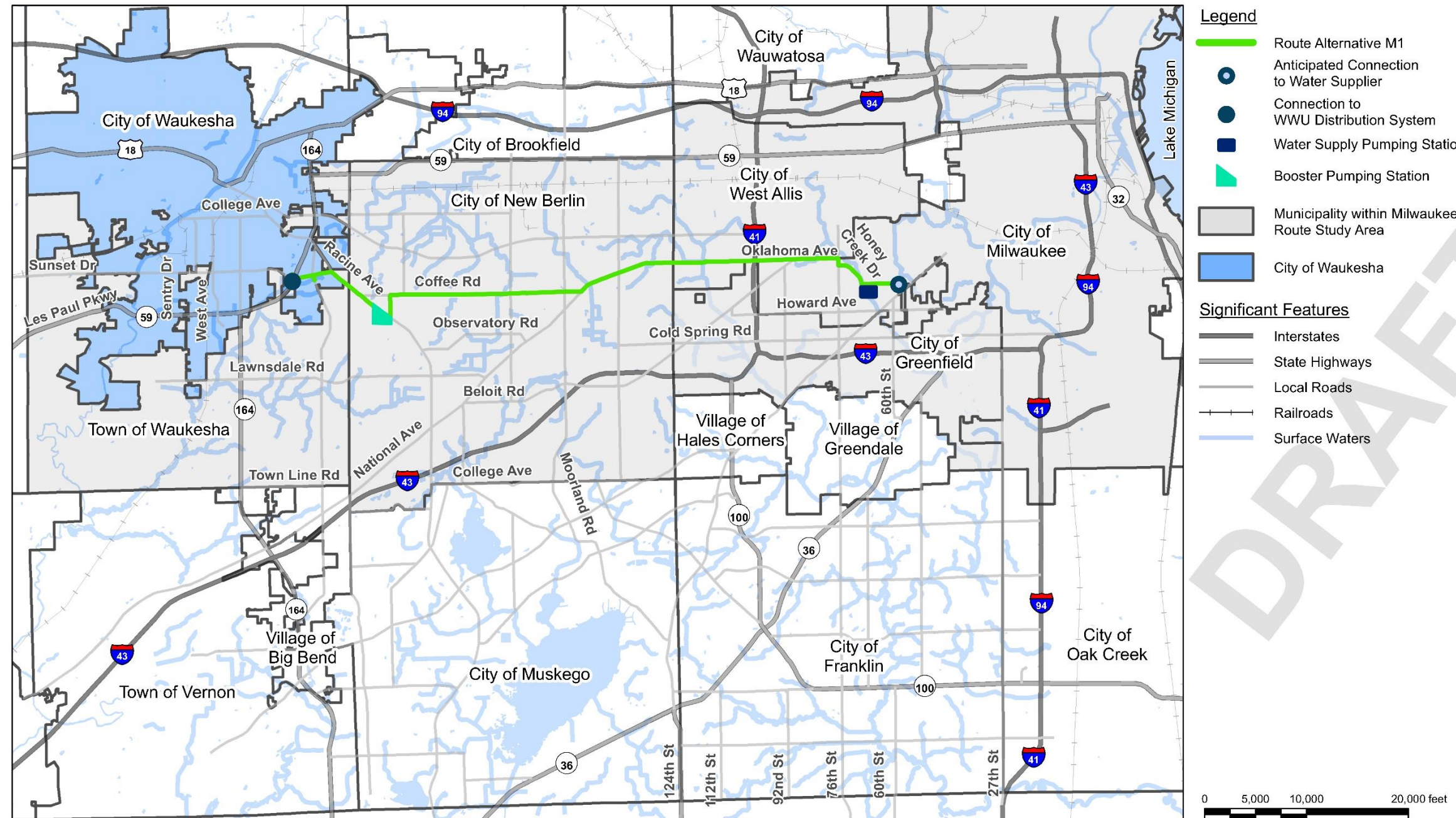
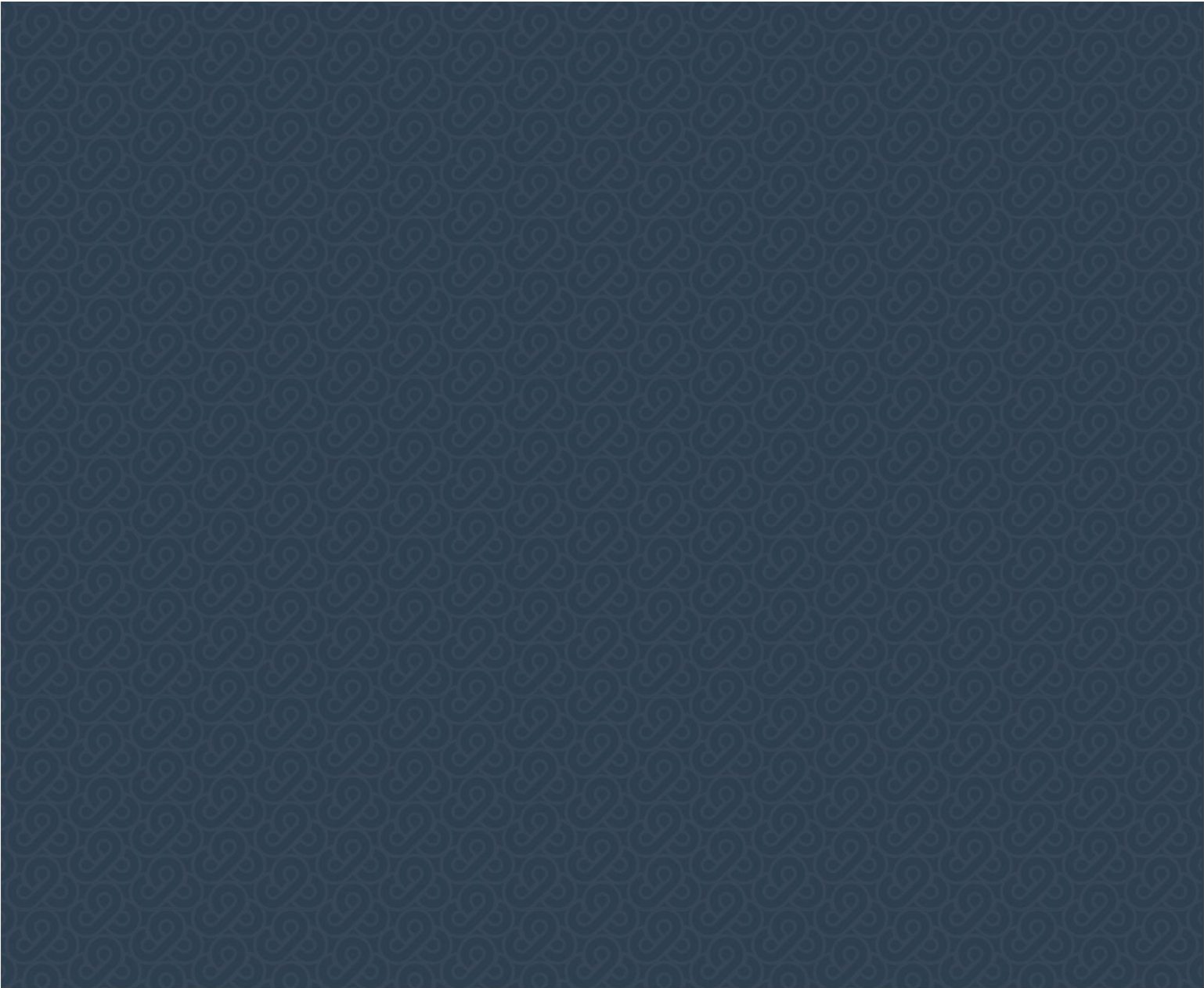


Figure 6-1 Preferred Route – Water Supply Pipeline



Appendix A – Route Alternatives M1, M2, and M3 Descriptions and Discussions



ROUTE ALTERNATIVE M1

The narrative for the Water Supply Pipeline alignment of Route Alternative M1 is presented below following the flow path, beginning at the anticipated connection to the Milwaukee Water Works (MWW) distribution system in the City of Milwaukee (Milwaukee) and ending at the connection to Waukesha Water Utility (WWU)'s distribution system in the City of Waukesha (Waukesha). Segments that are either in multiple routes or within the Common Corridor on a singular route are only described once at the segment or panel that first occurs per the direction of flow. The discussions provide the rationale for the preliminary horizontal alignments, potential traffic control strategies, and trenchless crossing methods. The photos provided for visual reference are numbered from east to west, south to north, and by time of year taken, starting at the anticipated connection to the MWW distribution system in Milwaukee.

Howard Avenue Segment (City of Milwaukee)

Panel 1 in **Appendix I** displays the beginning of Route Alternative M1. Howard Avenue is a four-lane, two-way road for the first 1,590 feet. West of the intersection of Howard Avenue and Forest Home Avenue, Howard Avenue transitions into a two-lane, two-way road, and 68th Street is a four-lane, two-way road. The land use around the route alternative in Panel 1 is primarily residential, with light commercial areas. On the east edge of Panel 1, the Water Supply Pipeline lies within the southernmost eastbound lane. This alignment is followed for 2,150 feet, at which point the Water Supply Pipeline shifts north beyond the pavement limits, but within the right-of-way to minimize road replacement. At the intersection of Howard Avenue and 68th Street, the pipeline turns north on 68th Street within the westernmost northbound lane for the remainder of Panel 1.

Approximately 150 feet east of the intersection of Howard Avenue and Forest Home Avenue, trenchless construction will begin for 590 linear feet via horizontal directional drilling (HDD). The trenchless crossing will minimize impacts to Honey Creek and traffic disruption to Forest Home Avenue. Construction activities within the eastbound southernmost lane of Howard Avenue, along the four-lane section, will require full closure of eastbound lanes, while traffic will be controlled through westbound lanes. Construction activities along Howard Avenue, between Forest Home Avenue and 68th Street, will require full closure of the road with detours for traffic along this portion of Howard Avenue. Construction activities within the westernmost northbound lane of 68th Street will require full closure of northbound lanes, while traffic will be controlled through the southbound lanes. Temporary access to both residential areas and commercial properties on the south side of Howard Avenue and east side of 68th Street will be provided where required. Construction will include restoration of the pavement, shoulder, curb and grass along Howard Avenue and 68th Street. See photos 1 through 4 for visual reference.



Photo 1
Looking east at the intersection of Howard Avenue and 60th Street



Photo 2
Looking west at the intersection of Howard Avenue and 60th Street



Photo 3
Looking west at the intersection of Forest Home Avenue and Howard Avenue



Photo 4
Looking northeast at the intersection of Forest Home Avenue and Howard Avenue

Honey Creek Drive Segment

Panel 2 in **Appendix I** continues from the north end of Panel 1. As shown in Panel 2, 68th Street is a four-lane, two-way road and Honey Creek Drive is a four-lane, two-way road with a center median. The land use around the route alternative in Panel 2 is primarily residential. On the south side of Panel 2, the Water Supply Pipeline lies within 68th Street's westernmost northbound lane until the intersection of 68th Street and Honey Creek Drive. At the southeast corner of this intersection, the pipeline turns northwest and lies within the westernmost northbound lane of Honey Creek Drive adjacent to the median for the remainder of Panel 2.

Approximately 85 feet southeast from the intersection of 68th Street and Honey Creek Drive, 70 linear feet of pipe casing will be installed by the jack and bore method. This construction method is used to minimize traffic disruption on 68th Street. Approximately 45 feet south of the intersection of Honey Creek Drive and Morgan Avenue, 170 linear feet of pipe casing will be installed by the jack and bore method. This construction method is used to minimize traffic Cold Spring on Morgan Avenue. Construction activities within the westernmost northbound lane of 68th Street will require full closure of northbound lanes, while traffic will be controlled through the southbound lanes. Construction activities within the westernmost northbound lane adjacent to the median on Honey Creek Drive will require full closure of northbound lanes, while traffic will be controlled through the southbound lanes. Temporary access to residential areas on the east side of 68th Street will be provided where required. Temporary access on Honey Creek Drive will not be provided as there are no residential properties requiring access. Construction will include restoration of the curb and road along 68th Street and Honey Creek Drive. See photos 5 and 8 for visual reference.



Photo 5

Looking southeast at the intersection of 68th Street and Honey Creek Drive



Photo 8

Looking south at the intersection of Honey Creek Drive and Morgan Avenue

Oklahoma Avenue Segment

Panel 3 in **Appendix I** continues from the north end of Panel 2. As shown in Panel 3, Honey Creek Drive is a four-lane, two-way road with a center median, 76th Street is a six-lane, two-way road with a center median, and Oklahoma Avenue is four-lane, two-way road with a center median. The land use around the route alternative in Panel 3 is primarily residential, with light commercial areas. On the southeast side of Panel 3, the Water Supply Pipeline lies within the westernmost northbound lane adjacent to the median on Honey Creek Drive. This alignment is followed until the intersection of Honey Creek Drive and 76th Street, at which point the pipeline turns north on 76th Street and lies within the westernmost southbound lane. This alignment is followed until the intersection of 76th Street and Oklahoma Avenue. At this point, the pipeline turns northwest and lies within westbound lane adjacent to the median.

Approximately 40 feet east of the intersection of Honey Creek Drive and 76th Street, 130 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on 76th Street. Approximately 30 feet south of the intersection of 76th Street and Oklahoma Avenue, 130 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on Oklahoma Avenue. Construction activities within the westernmost northbound lane adjacent to the

median on Honey Creek Drive will require full closure of northbound lanes, while northbound and southbound traffic will be controlled in the southbound lanes. Construction activities within the westernmost southbound lane of 76th Street will require closure of two southbound lanes, while traffic will be controlled through the remaining southbound lane and all northbound lanes on the east side of the road. Construction activities within the center lane adjacent to the median on Oklahoma Avenue will require full closure of both westbound lanes, while traffic will be controlled through the eastbound lanes. Temporary access to residential areas and commercial properties on the east side of Honey Creek Drive, the west side of 76th Street, and the north side of Oklahoma Avenue will be provided where required. Construction will include restoration of curb, gutters, grass, median, and road along Honey Creek Drive and Oklahoma Avenue. Construction activities will also include restoration of curb, grass, and road along 76th Street. See photos 11 through 13 for visual reference.



Photo 11

Looking north at the intersection of 76th Street and Oklahoma Avenue



Photo 12

Looking northwest at intersection of 76th Street and Oklahoma Avenue



Photo 13

Looking east at the intersection of Honey Creek Drive and 76th Street

Panel 4 in **Appendix I** continues from the west end of Panel 3. As shown in Panel 4, Oklahoma Avenue is four-lane, two-way road with a median. The land use in Panel 4 is residential, with light commercial areas. For the entirety of Panel 4, the Water Supply Pipeline is within the westbound lane adjacent to the median. Approximately 20 feet east of the intersection of Oklahoma Avenue and 84th Street, 110 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on 84th Street. Approximately 120 feet east off the intersection of Oklahoma Avenue and Beloit Road, 350 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on Beloit Road. Construction activities within the center lane adjacent to the median on Oklahoma Avenue will require full closure of the westbound lanes, while traffic will be controlled through the eastbound lanes. Construction will include restoration of the curb, gutters and road along Oklahoma Avenue. See photos 15, 16, 19, and 20 for visual reference.



Photo 15
Looking east at the intersection of Oklahoma Avenue and 84th Street



Photo 16
Looking west along Oklahoma Avenue at the intersection with 84th Street



Photo 19
Looking west at the intersection of Oklahoma Avenue and Beloit Road



Photo 20
Looking east at the intersection of Oklahoma Avenue and Beloit Road

Panel 5 in **Appendix I** continues from the west end of Panel 4. As shown in Panel 5, Oklahoma Avenue is a four-lane, two-way road with a center median. The land use around the route alternative in Panel 5 is primarily residential and commercial areas. For the entirety of Panel 5, the Water Supply Pipeline lies within the westbound lane adjacent to the median on Oklahoma Avenue.

Approximately 70 feet east of the intersection of Oklahoma Avenue and 92nd Street, 230 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on 92nd Street. Beginning 180 feet east of the Interstate 41 underpass, 440 linear feet of pipe will be installed via HDD. This construction method is used to avoid construction underneath the bridge of Interstate 41 over Oklahoma Avenue. Construction activities within the center lane adjacent to the median on Oklahoma Avenue will require full closure of westbound lanes, while traffic will be controlled through the eastbound lanes. Construction will include curb, gutters, median, and road restoration along Oklahoma Avenue. See photos 21 through 23, 26, and 27 for visual reference.



Photo 21

Looking west at the intersection of Oklahoma Avenue and 92nd Street



Photo 22

Looking east at the intersection of Oklahoma Avenue and South 92nd Street

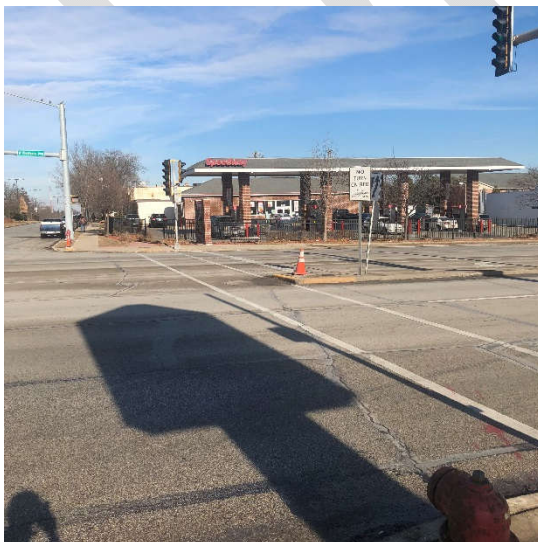


Photo 23

Looking north at the intersection of Oklahoma Avenue and 92nd Street

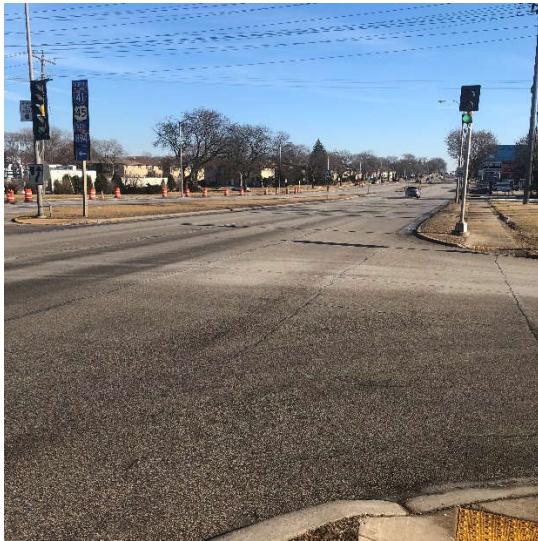


Photo 26

Looking east at the intersection of Oklahoma Avenue and 100th Street



Photo 27

Looking west along Oklahoma Avenue to the Interstate 41 highway underpass

Panel 6 in **Appendix I** continues from the west end of Panel 5. As shown in Panel 6, Oklahoma Avenue is a four-lane, two-way road with a center median. The land use along the route alternative in Panel 6 is primarily comprised of residential and commercial areas. For the entirety of Panel 6, the Water Supply Pipeline lies within the westbound lane adjacent to the median on Oklahoma Avenue. Approximately 30 feet east of the intersection of Oklahoma Avenue and 108th Street, 190 linear feet of pipe casing will be installed via the jack and bore method. This construction method is used to minimize traffic disruption on 108th Street. Construction activities within the center lane adjacent to the median on Oklahoma Avenue will require full closure of westbound lanes, while westbound traffic will be controlled through the eastbound lanes. Construction will include curb, gutter, median, and road restoration along Oklahoma Avenue. See photos 31 and 32 for visual reference.



Photo 31

Looking west along Oklahoma Avenue at the intersection with 108th Street



Photo 32

Looking east at the intersection of Oklahoma Avenue and 108th Street

Panel 7 in **Appendix I** continues from the west end of Panel 6. As shown in Panel 7, Oklahoma Avenue is a four-lane, two-way road with a center median. East of the intersection of Oklahoma Avenue and National Avenue, the road transitions to a six-lane, two-way road with a center median. Oklahoma Avenue transitions back to a four-lane, two-way road with bike lanes west of the Root River crossing. The land use around the route alternative in Panel 7 is primarily residential, with light commercial areas. On the east side of Panel 7, the Water Supply Pipeline lies within the westbound lane of Oklahoma Avenue, adjacent to the median. The pipeline alignment continues due west for 1,200 feet, crossing the curve of Oklahoma Avenue and entering a landscaped area within the right-of-way grass. This alignment jogs south 40 feet and continues due west for 450 feet. At this point, the pipeline lies within the eastbound shoulder.

Approximately 30 feet east of the intersection of Oklahoma Avenue and Wollmer Road, 140 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on Wollmer Road. Approximately 160 feet southeast of the intersection of Oklahoma Drive and National Avenue, 100 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on Oklahoma Avenue. Approximately 340 feet to the east of the intersection of Oklahoma Avenue and Root River Parkway, 1,120 linear feet of pipeline will be installed via HDD to cross the Root River. Construction activities within the center lane adjacent to the median on Oklahoma Avenue will require full closure of two westbound lanes, while traffic will be controlled through the eastbound lanes for this portion of the road. Construction activities within the shoulder and bike lane of the eastbound lane of Oklahoma Avenue west of the Root River crossing will require closure of the southernmost eastbound lane, while traffic will be controlled through one eastbound lane. Temporary access to residential properties on the south side of Oklahoma Avenue will be provided where required and no commercial properties require temporary access. Construction will include restoration of pavement, bike lane, curb, gutters, grass, median, road, and shoulder along Oklahoma Avenue. See photos 35 through 37 for visual reference.



Photo 35

Looking east at the intersection of Oklahoma Avenue and Wollmer Road



Photo 36

Looking northeast across Oklahoma Avenue, immediately south of the intersection of Oklahoma Avenue and National Avenue



Photo 37

Looking west to the Root River near the intersection of Oklahoma Avenue and National Avenue

National Avenue Segment

Panel 8 in **Appendix I** continues from the west end of Panel 7. As shown in Panel 8, Oklahoma Avenue is a four-lane, two-way road with a center median and bike lanes, while National Avenue is a four-lane, two-way road with a center turning lane. The land use around the route alternative in Panel 8 is primarily commercial, with light residential areas. For the entirety of Panel 8, the Water Supply Pipeline lies within the southernmost eastbound lane.

Approximately 40 feet east of the intersection of Oklahoma Avenue and 124th Street, 150 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on 124th Street. Approximately 70 feet east of the intersection of National Avenue and Highpointe Drive, 390 linear feet of pipeline will be installed by HDD. This construction method is used to minimize impacts to the creek and traffic disruption on Highpointe Drive. Construction activities within the shoulder and bike lane of the westbound lane of Oklahoma Avenue will require closure of the southernmost eastbound lane, while traffic will be controlled through the one eastbound lane. Construction activities within the southernmost eastbound lane of National Avenue will require closure of the eastbound lanes, while traffic will be controlled through the westbound lanes on the north side of National Avenue. Temporary access to commercial and residential properties on the south side of National Avenue and Oklahoma Avenue will be provided where required. Construction will include pavement, curb, gutter, bike lane, shoulder, and road restoration along Oklahoma Avenue and National Avenue. See photos 40, 41, 45, and 46 for visual reference.



Photo 40

Looking east at the intersection of Oklahoma Avenue and 124th Street



Photo 41

Looking west at the intersection of Oklahoma Avenue and 124th Street



Photo 45

Looking west at the intersection of National Avenue and Highpointe Drive

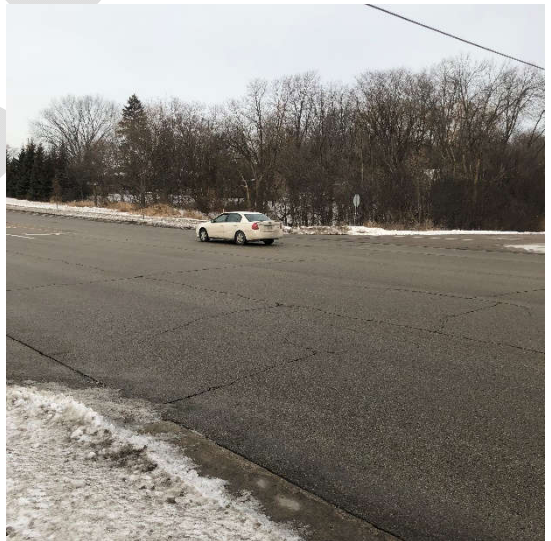


Photo 46

Looking northwest at the intersection of National Avenue and Highpointe Drive

Panel 9 in **Appendix I** continues from the west end of Panel 8. As shown in Panel 9, National Avenue is a four-lane, two-way road with a center turning lane. The land use around the route alternative in Panel 9 is primarily comprised of residential and commercial areas. On the east side of Panel 9, the Water Supply Pipeline lies within the southernmost eastbound lane for 40 feet. At this point, the pipeline turns north on National Avenue and lies within the northernmost westbound lane. This alignment is followed for the remainder of Panel 9.

Approximately 60 feet east of the intersection of National Avenue and Sunny Slope Road, 170 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic

disruption on Sunny Slope Road. Construction activities within the southernmost eastbound lane of National Avenue will require closure of the eastbound lanes, while traffic will be controlled through the westbound lanes on the north side of National Avenue. Construction activities within the northernmost westbound lane of National Avenue will require closure of the westbound lanes, while traffic will be controlled through the eastbound lanes on the south side of National Avenue. Temporary access to residential and commercial properties on the north and south sides of National Avenue will be provided where required. Construction will include pavement, curb, gutter, and road restoration along National Avenue. See photos 49 and 50 for visual reference.



Photo 49

Looking southwest at the intersection of National Avenue and Sunny Slope Road



Photo 50

Looking northeast at the intersection of National Avenue and Sunny Slope Road

Panel 10 in **Appendix I** continues from the west end of Panel 9. As shown in Panel 10, National Avenue is a four-lane, two-way road with a center-turning lane. The land use around the route alternative in Panel 10 is primarily residential and commercial. On the east end of Panel 10, the Water Supply Pipeline lies within the northernmost westbound lane for 1,000 feet. Thereafter, the pipeline lies outside of pavement limits, but within the right-of-way to minimize road replacement. Southwest of the intersection of National Avenue and Acredale Drive, the pipeline lies within the southbound shoulder until the pipeline turns west on Coffee Road.

Approximately 40 feet east of the intersection of National Avenue and Acredale Drive, 300 linear feet of pipeline will be installed via HDD. This construction method is used to minimize impacts to the creek and traffic disruption on Acredale Drive. Construction activities within the northernmost westbound lane of National Avenue will require closure of the westbound lanes, while traffic will be controlled through the eastbound lanes on the south side of National Avenue. Construction activities outside pavement limits on the north side of National Avenue will require closure of the northernmost westbound lane, while traffic will be controlled through the center westbound lane. Both eastbound lanes on the south side of the road will be left open to traffic. Construction activities within the westbound lane shoulder will require closure of the northernmost westbound lane, while traffic will be controlled through the center westbound lane, while keeping both eastbound lanes on the south side of the road open to traffic. Temporary access to residential and commercial properties on the north side of National Avenue will be provided where required. Construction will include restoration of the pavement, curb, gutter, road, shoulder, sidewalks, and grass along National Avenue. See Photos 53 through 56 for visual reference.



Photo 53

*Looking southwest at the intersection of
National Avenue and Acredale Drive*



Photo 54

*Looking northeast at the intersection of
National Avenue and Acredale Drive*

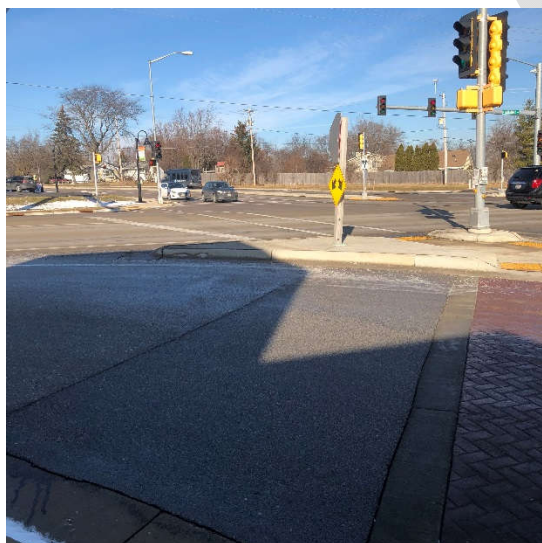


Photo 55

*Looking north at the intersection of National
Avenue and Coffee Road*



Photo 56

*Looking northeast at the intersection of
National Avenue and Coffee Road*

Coffee Road Segment

Panel 11 in **Appendix I** continues from the west end of Panel 10. As shown in Panel 11, Coffee Road is a two-lane, two-way road with bike lanes. The land use around the route alternative in Panel 11 is primarily residential, with light commercial areas. On the east end of Panel 11, the Water Supply Pipeline lies within the westbound shoulder and bike lane of Coffee Road for 1,930 feet. At this point, the road width narrows, but the pipeline maintains the horizontal offset from the centerline and lies outside pavement limits but within the right-of-way for the remainder of Panel 11.

Approximately 50 feet east of the intersection of Coffee Road and Moorland Road, 180 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on Moorland Road. Construction activities along Coffee Road, between National Avenue and Moorland Road, will require full closure of the westbound lane, while traffic will be controlled through both eastbound lanes on the south side of Coffee Road. Construction activities outside pavement limits on the north side of Coffee Road will require closure of the westbound lane, while traffic will be controlled within the eastbound lane along this portion of Coffee Road. Temporary access to residential properties on the north side of Coffee Road will be provided where required and no commercial properties require temporary access. Construction will include restoration of the pavement, curb, gutter, road and grass along Coffee Road. See photos 58 and 59 for visual reference.



Photo 58

Looking west at the intersection of Coffee Road and Moorland Road



Photo 59

Looking east near intersection of Coffee Road and Moorland Road

Panel 12 in **Appendix I** continues from the west end of Panel 11. As shown in Panel 12, Coffee Road is a two-lane, two-way road with bike lanes. The land use around the route alternative in Panel 12 is primarily agricultural, with light residential areas. On the east side of Panel 12, the Water Supply Pipeline lies within the westbound bike lane and shoulder for the easternmost 1,770 feet. At this point, the Water Supply Pipeline jogs northwest and lies outside pavement limits, but within the right-of-way, to minimize pavement restoration. This alignment is followed for the remainder of Panel 12.

Approximately 80 feet east of the intersection of Coffee Road and Calhoun Road, 220 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on Calhoun Road. Construction activities within the westbound shoulder or outside pavement limits on the north side of Coffee Road will require closure of the westbound lane, while traffic will be controlled within the eastbound lane along this portion of Coffee Road. Temporary access to residential areas on the north side of Coffee Road will be provided where required. Construction will include restoration of the curb, gutter, grass, bike lane, and shoulder along Coffee Road. See photo 68 for visual reference.



Photo 68

Looking east at the intersection of Coffee Road and Calhoun Road

Panel 13 in **Appendix I** continues from the west end of Panel 12. As shown in Panel 13, Coffee Road is a two-lane, two-way road. The land use around the route alternative in Panel 13 is primarily agricultural, with light residential areas. For the entirety of Panel 13, the Water Supply Pipeline lies north of Coffee Road in the right-of-way, within the shoulder or outside of pavement limits, to minimize pavement restoration.

Approximately 2,040 feet east of the intersection of Coffee Road and Woelfel Road, 380 linear feet of pipeline will be installed via HDD. This construction method is used to minimize impacts to the creek and culvert crossing Coffee Road. Construction activities with the westbound shoulder or outside pavement limits on the north side of Coffee Road will require closure of the westbound lane, while traffic will be controlled within the eastbound lane along this portion of Coffee Road. Construction will include restoration of the grass and shoulder along Coffee Road. See photo 69 for visual reference.



Photo 69

Looking east along Coffee Road at the waterway 540 feet west of Calhoun Road of Coffee Road and Calhoun Road

Panel 14 in **Appendix I** continues from the west end of Panel 13. As shown in Panel 14, Coffee Road is a two-lane, two-way road. The land use around the route alternative in Panel 14 is primarily agricultural and residential. For the

entirety of Panel 14, the Water Supply Pipeline lies north of Coffee Road in the right-of-way, but outside of pavement limits, to minimize pavement restoration.

Construction activities will require closure of the westbound lane, while traffic will be controlled in the eastbound lane. Temporary access to residential areas on the north side of Coffee Road will be provided where required. Construction will include restoration of the pavement and grass along Coffee Road.

Panel 15 in **Appendix I** continues from the west end of Panel 14. As shown in Panel 15, Coffee Road is a two-lane, two-way road. The land use around the route alternative in Panel 15 is primarily residential, with light agricultural areas. For the entirety of Panel 15, the Water Supply Pipeline lies north of Coffee Road, outside of pavement limits or within the shoulder, but within the right-of-way to minimize pavement restoration.

Construction activities with the westbound shoulder or outside pavement limits on the north side of Coffee Road will require closure of the westbound lane, while traffic will be controlled in the eastbound lane along this portion of Coffee Road. Temporary access to residential areas on the north side of Coffee Road will be provided where required. Construction will include restoration of the pavement, grass and shoulder along Coffee Road.

Panel 16 in **Appendix I** continues from the west end of Panel 15. As shown in Panel 16, Coffee Road is a two-lane, two-way road and Swartz Road is a two-lane, two-way road. The land use around the route alternative in Panel 16 is primarily agricultural with residential areas. On the east side of Panel 16, the Water Supply Pipeline lies north of Coffee Road but within the right-of-way to minimize pavement restoration. Approximately 1,300 feet east of the intersection of Coffee Road and Swartz Road, the pipeline turns southwest and lies within the westbound lane of Coffee Road until the intersection of Coffee Road and Swartz Road. At this point, the pipeline turns south on Swartz Road and lies within the southbound lane. This alignment is followed for the remainder of Panel 16.

Construction activities within the westbound shoulder or outside pavement limits on the north side of Coffee Road will require closure of the westbound lane, while traffic will be controlled within the eastbound lane along this portion of Coffee Road. Construction activities within Coffee Road westbound lane will require full closure with detours for traffic along this portion of Coffee Road. Construction activities within Swartz Road southbound lane will require full closure with detours for traffic along this portion of Swartz Road. Temporary access to residential areas on the north side of Coffee Road and east side of Swartz Road will be provided where required. Construction will include restoration of the road and grass along Coffee Road and Swartz Road.

Racine Avenue Segment

Panel 17 in **Appendix I** continues from the south end of Panel 16. As shown in Panel 17, Swartz Road and Racine Avenue are two-lane, two-way roads. The land use around the route alternative in Panel 17 is primarily agricultural, with light residential areas. On the north end of Panel 17, the Water Supply Pipeline lies within the southbound lane of Swartz Road until the intersection of Swartz Road and Racine Avenue. At this point, the pipeline turns southwest to converge into the Common Corridor with the Return Flow Pipeline and lies south of Racine Avenue southbound lane. This alignment is followed for 1,530 feet northwest of the intersection after connecting to the water reservoirs and BPS on the southwest quadrant of Racine Avenue and Swartz Road. At this point, the Common Corridor begins and jogs north of Racine Avenue. This alignment is followed for the remainder of Panel 17.

Approximately 30 feet northeast of the intersection of Swartz Road and Racine Avenue, 90 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on Racine Avenue. Construction activities within Swartz Road southbound lane will require full closure with detours for

traffic along this portion of Swartz Road. Construction activities along the south shoulder of Racine Avenue will require closure of the southbound lane, while traffic will be controlled within the northbound lane along this portion of Racine Avenue. Construction activities along the north shoulder of Racine Avenue will require full closure of the northbound lane, while traffic will be controlled within the southbound along this portion of Racine Avenue. Temporary access to residential areas on the west side of Swartz Road, and north side of Racine Avenue will be provided where required. Construction will include restoration of the road, grass and shoulder along Swartz Road and Racine Avenue. See photos 80 through 83 for visual reference.



Photo 80

*Looking north along at the intersection of
Swartz Road and Racine Avenue*



Photo 81

*Looking southeast at the intersection of
Swartz Road and Racine Avenue*



Photo 82

*Looking southwest at the intersection of
Swartz Road and Racine Avenue*



Photo 83

*Looking northwest at the intersection of
Swartz Road and Racine Avenue*

Panel 18 in **Appendix I** continues from the west end of Panel 17. As shown in Panel 18, Racine Avenue is a two-lane, two-way road. The land use around the route alternative in Panel 18 is residential. On the southeast side of Panel 18, the Common Corridor lies north of Racine Avenue within the shoulder and outside pavement limits to minimize road replacement. This alignment is followed for 110 feet northwest of the intersection of Racine Avenue and Coffee Road. At this point the Common Corridor shifts south of Racine Avenue. This alignment is followed for the remainder of Panel 18.

Construction activities along the north side shoulder of Racine Avenue will require full closure of the northbound lane, while traffic will be controlled within the southbound lane along this portion of Racine Avenue. Construction activities along the south side shoulder of Racine Avenue will require closure of the southbound lane, while traffic will be controlled within the northbound lane along this portion of Racine Avenue. Temporary access to residential areas on the north and south side of Racine Avenue will be provided where required. Construction will include restoration of the pavement, grass and shoulder along Racine Avenue.

Sunset Drive Segment

Panel 19 in **Appendix I** continues from the north end of Panel 18. As shown in Panel 19, Racine Avenue and Sunset Drive are two-lane, two-way roads. The land use around the route alternative in Panel 19 is primarily residential. On the southeast, side of Panel 19, the Common Corridor lies south of Racine Avenue within the shoulder and outside pavement limits to minimize pavement restoration until the intersection of Racine Avenue and Sunset Drive. At this point, the pipeline turns southwest on Sunset Drive and lies within the eastbound lane and outside pavement limits, but within the right-of-way. This alignment is followed for the remainder of Panel 19. At the intersection of Sunset Drive and Guthrie Road, a spur of the Water Supply Pipeline turns south to the anticipated connection to WWU's distribution system to Hunter Tower through an existing 16-inch water main. Construction activities along the south side shoulder of Racine Avenue will require closure of the southbound lane, while traffic will be controlled within the northbound along this portion of Racine Avenue. Construction activities along Sunset Drive will require full closure with detours for traffic east of Guthrie Road and closure of the eastbound lane west of Guthrie Road. Construction along Guthrie Road will require closure of the northbound lane. Temporary access to residential areas on the south side of Racine Avenue and Sunset Drive will be provided where required. Construction will include restoration of the road, grass and shoulder along Racine Avenue, Sunset Drive, and Guthrie Road. See photo 84 for visual reference.



Photo 84

*Looking southwest at the intersection of
Sunset Drive and Guthrie Road*

Panel 20 in **Appendix I** continues from the west end of Panel 19. As shown in Panel 19, Sunset Drive is a two-lane, two-way road and Les Paul Parkway is a six-lane, two-way road with a center median. The land use around the route alternative in Panel 20 is primarily residential. On the east end of Panel 20, the Common Corridor lies in the eastbound lane of Sunset Drive. This alignment is followed for 1,110 feet. At this point, the Water Supply Pipeline alignment diverges from the Common Corridor. The Water Supply Pipeline alignment continues northwest for 550 feet.

Approximately 350 linear feet of pipe casing will be installed via the jack and bore method to cross both Sunset Drive and Les Paul Parkway in a single trenchless crossing. This construction method is used to minimize traffic disruption to Sunset Drive and Les Paul Parkway. Temporary access to residential areas along this portion of Sunset Drive will be provided where required. Construction will include restoration of the curb, gutter, road, grass and shoulder along Sunset Drive and Les Paul Parkway. See photos 85 through 87 for visual reference.

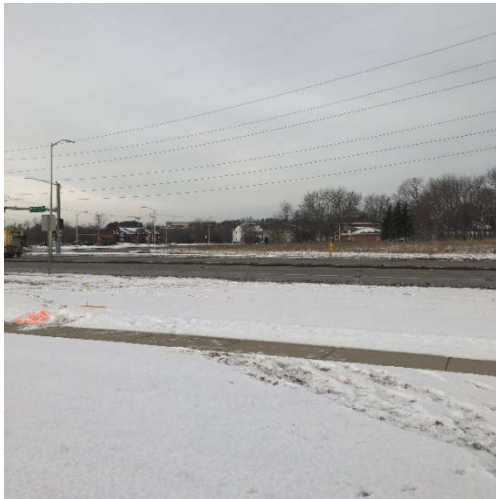


Photo 85

Looking west at the intersection of Les Paul Parkway and Sunset Drive



Photo 86

Looking northwest at the intersection of Les Paul Parkway and Sunset Drive

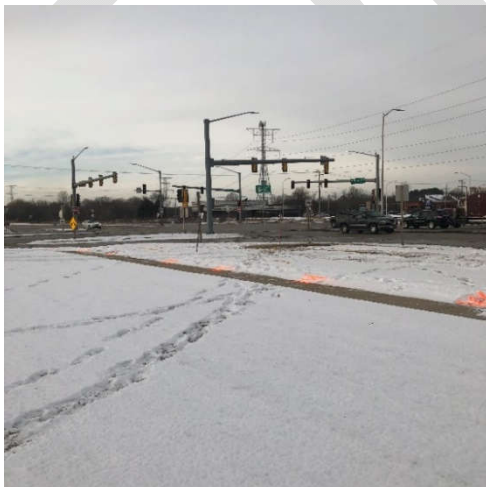


Photo 87

Looking southwest at the intersection of Les Paul Parkway and Sunset Drive

ROUTE ALTERNATIVE M2

The narrative for the Water Supply Pipeline alignment of Route Alternative M2 is presented below following the flow path, beginning at the anticipated connection to the MWW distribution system in Milwaukee and ending at the connection to WWU's distribution system in Waukesha. Segments that are either in multiple routes or within the Common Corridor on a singular route are only described once at the segment or panel that first occurs per the direction of flow. The discussion provides the rationale for the preliminary horizontal alignment, traffic control strategies, and trenchless crossing methods. The photos provided for visual reference are numbered from east to west, south to north, and by time of year taken, starting at the anticipated connection to the water supplier in Milwaukee.

Howard Avenue Segment

Panel 1 in **Appendix I** displays the beginning of the Route Alternative M2 Water Supply Pipeline. As shown in Panel 1, Howard Avenue is a four-lane, two-way road. Forest Home Avenue is a four-lane, two-way road, with bike lanes and a center median. The land use around the route alternative in Panel 1 is primarily residential and commercial. On the east side of Panel 1, the Water Supply Pipeline lies within the southernmost eastbound lane. At the intersection of Howard and Forest Home Avenues, the alignment turns southwest on Forest Home Avenue within the south side bike lane and shoulder for 390 feet. At this point, the Water Supply Pipeline turns west and lies within the westernmost northbound lane, adjacent to the median. This alignment is followed for the remainder of Panel 1.

Beginning at the southeast corner of the intersection of Howard Avenue and Forest Home Avenue, 290 linear feet of pipe will be installed by HDD. This construction method is used to minimize impacts to a creek and culvert. Construction activities within the southernmost eastbound lane along Howard Avenue will require the closure of both eastbound lanes, while traffic will be controlled through the westbound lanes. Construction activities within the bike lane and shoulder lane on the south side of Forest Home Avenue will require the closure of the northbound, southernmost lane, bike lane and shoulder, while traffic will be controlled to one northbound lane. Construction activities within the lane adjacent to the median on the northbound of Forest Home Avenue will require closure of both northbound lanes, while traffic will be controlled through the southbound lanes. Temporary access to residential areas and commercial properties on the south side of Howard Avenue and the east side of Forest Home Avenue will be provided where required. Construction will include restoration of the pavement, curb, gutter, road, shoulder and bike lanes along Howard Avenue and Forest Home Avenue. See photos 1 through 4 for visual reference.

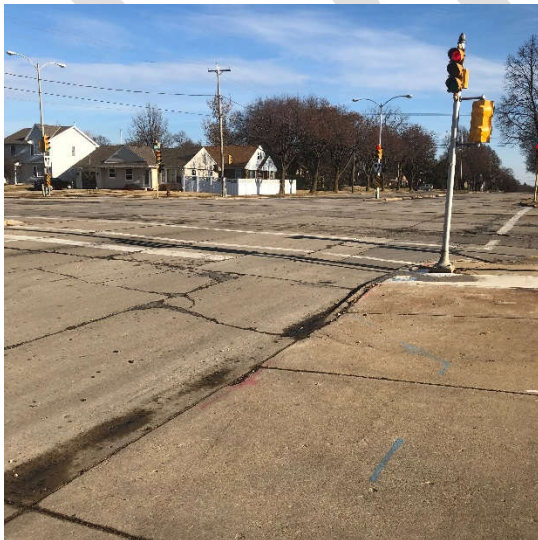


Photo 1

Looking east at the intersection of Howard Avenue and 60th Street

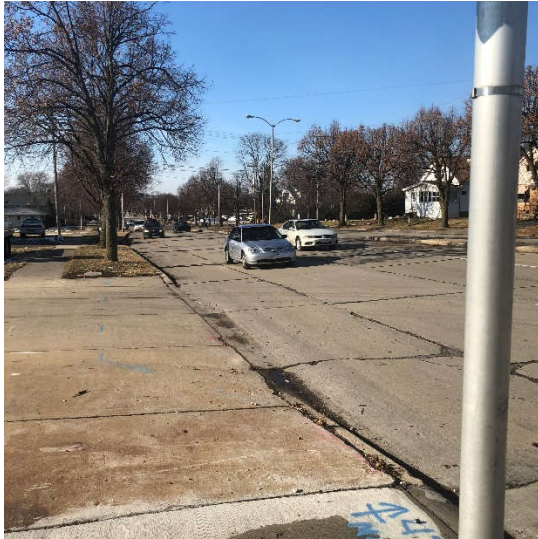


Photo 2

Looking west at the intersection of Howard Avenue and 60th Street



Photo 3

Looking northeast at the intersection of Forest Home Avenue and Howard Avenue



Photo 4

Looking east at the intersection of Forest Home Avenue and Howard Avenue

Forest Home Avenue Segment

Panel 2 in **Appendix I** continues from the southwest end of Panel 1. As shown in Panel 2, Forest Home Avenue is a four-lane, two-way road, with bike lanes and a center median. Cold Spring Road is a four-lane, two-way road. The land use around the route alternative in Panel 2 is primarily residential and commercial areas. On the northeast side of Panel 2, the Water Supply Pipeline lies within the westernmost northbound lane of Forest Home Avenue. This alignment is followed for 1,950 feet until the alignment shifts to the west side of Forest Home Avenue and lies within the bike lane and shoulder until the intersection of Forest Home Avenue and Cold Spring Road. At this point, the pipeline turns west on Cold Spring Road to lie within the northernmost westbound lane for the remainder of Panel 2.

Approximately 80 feet northeast of the intersection of Forest Home Avenue and 68th Street, 240 linear feet of pipe casing will be installed by using the jack and bore method. Approximately 50 feet east of the intersection of Cold Spring Road and 76th Street, 220 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on 68th and 76th Streets. Construction activities within the westernmost northbound lane of Forest Home Avenue will require closure of both northbound lanes, while traffic will be controlled through the southbound lanes. Construction activities within the southbound bike lane and shoulder of Forest Home Avenue will require the closure of the westernmost southbound lane, while traffic will be controlled to one southbound lane, while keeping both northbound lanes of the road open. Temporary access will be provided to the commercial properties on the north side of Cold Spring Road where required and no temporary access will be need for residential properties. Construction will include restoration of the road, bike lanes, and shoulder along Forest Home Avenue. Construction will also include restoration of curb, gutter, grass, and road along Forest Home Avenue and Cold Spring Road. See photos 6, 7, 9, 10, and 14 for visual reference.

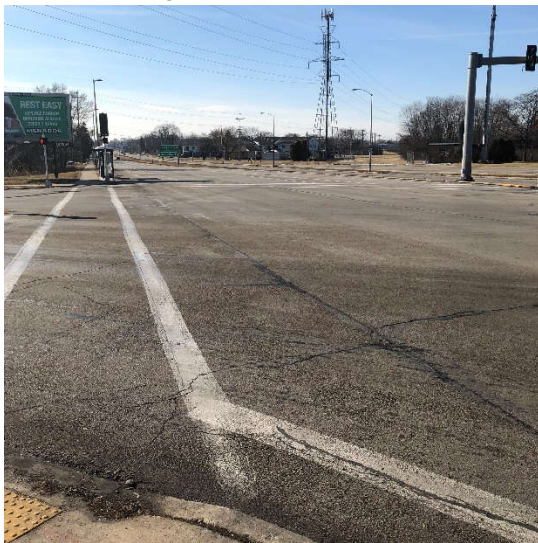


Photo 6

Looking southwest at the intersection of Forest Home Avenue and 68th Street



Photo 7

Looking northeast at the intersection of Forest Home Avenue and 68th Street



Photo 9

Looking northeast at the intersection of Forest Home Avenue and Cold Spring Road



Photo 10

Looking southeast at the intersection of Forest Home Avenue and Cold Spring Road



Photo 14

Looking east at the intersection of Cold Spring Road and 76th Street

Cold Spring Road Segment

Panel 3 in **Appendix I** continues from the west end of Panel 2. As shown in Panel 3, Cold Spring Road is a two-lane, two-way road with parking lanes on each side. The land use around the route alternative in Panel 3 is primarily residential areas. On the east side of Panel 3, the Water Supply Pipeline lies within the westbound parking lane of Cold Spring Road. This alignment is followed for 2,100 feet, until 200 feet east of the intersection of Cold Spring Road and 84th Street. At this point, the pipeline shifts south to lie within the westbound lane. This alignment is followed for the remainder of Panel 3.

Construction activities within the westbound parking lane and westbound lane along Cold Spring Road will require the closure of the westbound lane, while traffic will be controlled through the eastbound and parking lanes on the south side of the road. Temporary access to residential areas on the north side of Cold Spring Road will be provided where required. Construction will include restoration of the curb, gutter, and pavement along Cold Spring Road. See photos 17 and 18 for visual reference.



Photo 17

Looking east at the intersection of Cold Spring Road and 84th Street



Photo 18

Looking west at the intersection of Cold Spring Road and 84th Street

Panel 4 in **Appendix I** continues from the west end of Panel 3. As shown in Panel 4, Cold Spring Road is a two-lane, two-way road with parking lanes on each side until the intersection of Cold Spring Road and 92nd Street. At this point, Cold Spring Road transition into a two-lane, two-way road. The land use around the route alternative in Panel 4 is primarily residential areas. From the east end of this panel until the intersection of Cold Spring Road and 92nd Street, the Water Supply Pipeline lies within the westbound parking lane. West of the intersection of Cold Spring Road and 92nd Street, the pipeline lies within the westbound lane.

At the intersection of Cold Spring Road and 92nd Street, 150 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on 92nd Street. Construction activities within the westbound parking lane along Cold Spring Road until 92nd Street will require the closure of westbound lane, while traffic will be controlled through the eastbound and parking lanes on the south side of the road. Construction activities within the westbound lane along Cold Spring Road west of the intersection of Cold Spring Road and 92nd Street will require full closure of the Cold Spring Road, requiring a detour. Temporary access to residential areas on the north side of Cold Spring Road will be provided where required. Construction will include restoration of the pavement, curb, gutter, grass, and road along Cold Spring Road. See photos 24 and 25 for visual reference.



Photo 24

Looking west at the intersection of Cold Spring Road and 92nd Street



Photo 25

Looking east at the intersection of Cold Spring Road and 92nd Street

Panel 5 in **Appendix I** continues from the west end of Panel 4. As shown in Panel 5, Cold Spring Road is a two-lane, two-way road east of 400 feet east of the intersection of Cold Spring Road and 104th Street. At this point Cold Spring Road transitions into a two-lane, two-way road with bike lanes on both sides. The land use around the route alternative in Panel 5 is primarily residential and commercial areas. For the entirety of Panel 5, the Water Supply Pipeline lies within the westbound lane of Cold Spring Road.

At a point 350 feet west of the intersection of Cold Spring Road and 99th Street, 270 of pipe casing will be installed using the jack and bore method. This construction method is used to avoid open cut construction underneath the bridge of Interstate 41 over Cold Spring Road. At the intersection of Cold Spring Road and 104th Street, 90 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on 104th Street. Approximately 300 feet west of the intersection of Cold Spring Road and 104th Street, 800 linear feet of pipe will be installed via HDD. This construction method is used to avoid impacts to the Root River and a tributary to the Root River. At the intersection of Cold Spring Road and 108th Street, 460 linear feet of pipe will be installed via HDD. This construction method is used to minimize traffic disruption on 108th Street and avoid impacts to a creek and culvert (continued on Panel 6). For the entirety of Panel 5, construction activities will require the full closure of Cold Spring Road, requiring a detour. Temporary access to residential and commercial areas along Cold Spring Road will be provided where required. Construction will include restoration of pavement, curb, grass and road along Cold Spring Road. See photos 28 through 30, 33, and 34 for visual reference.



Photo 28

*Looking west along Cold Spring Road to the
Interstate 41 highway underpass*



Photo 29

*Looking west at the intersection of Cold
Spring Road and 104th Street*



Photo 30

*Looking west along Cold Spring Road at the
Root River waterway crossing on Cold
Spring Road*



Photo 33

*Looking west at the intersection of Cold
Spring Road and 108th Street*



Photo 34

Looking east at the intersection of Cold Spring Road and 108th Street

Panel 6 in **Appendix I** continues from the west end of Panel 5 at the intersection of Cold Spring Road and 108th Street. As shown in Panel 6, Cold Spring Road is a two-lane, two-way road. The land use around the route alternative in Panel 6 is primarily comprised of residential and commercial areas. On the east side of Panel 6, the Water Supply Pipeline lies within the westbound lane of Cold Spring Road. This alignment is followed until 280 feet west of the intersection of Cold Spring Road and 116th Street. At this point, the pipeline shifts south to lie within the eastbound lane.

As described and shown in Panel 5, the remaining length of the pipe installed via HDD at the intersection of Cold Spring Road and 108th Street is shown. Approximately 400 feet west of the intersection of Cold Spring Road and 116th Street, 450 linear feet of pipe will be installed via HDD. This construction method is used to avoid impacts to a creek and culvert. For the entirety of Panel 6, construction activities will require the full closure of Cold Spring Road, requiring a detour. Temporary access to residential and commercial areas on the north side of Cold Spring Road will be provided where required. Construction will include restoration of the pavement, curb, gutter, grass and road along Cold Spring Road. See photo 38 for visual reference.



Photo 38

Looking west along Cold Spring Road at the waterway west of the intersection of Cold Spring Road and 118th Street

Panel 7 in **Appendix I** continues from the west end of Panel 6. As shown in Panel 7, Cold Spring Road is a two-lane, two-way road. The land use around the route alternative in Panel 7 is primarily residential areas. From the east end of Panel 7, the Water Supply Pipeline lies within the eastbound lane of Cold Spring Road. This alignment is followed until a point 80 feet west of the intersection of Cold Spring Road and 124th Street. At this point, the pipeline shifts north to lie within the westbound lane. This alignment is followed for the remainder of Panel 7. At the intersection of Cold Spring and Beloit Roads, 300 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on Beloit Road. At the intersection of Cold Spring Road and 124th Street, 120 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on 124th Street. For the entirety of Panel 7, construction activities will require the full closure of Cold Spring Road, requiring a detour. Temporary access to residential areas on both the north and south sides of Cold Spring Road will be provided where required. Construction will include restoration of the pavement, curb, gutter, and road along Cold Spring Road. See photos 39, 42, and 43 for visual reference.



Photo 39

Looking west at the intersection of Cold Spring Road and Beloit Road



Photo 42

Looking west at the intersection of Cold Spring Road and 124th Street



Photo 43

Looking east at the intersection of Cold Spring Road and 124th Street

Panel 8 in **Appendix I** continues from the west end of Panel 7 at the intersection of Cold Spring Road and 127th Street. As shown in Panel 8, Cold Spring Road is a two-lane, two-way road. The land use around the route alternative in Panel 8 is primarily residential, with light agricultural areas. For the entirety of Panel 8, the Water Supply Pipeline lies within the westbound lane of Cold Spring Road, and construction activities will require the full closure of Cold Spring Road. Temporary access to residential and agricultural areas on both the north and south sides of Cold Spring Road will be provided where required. Construction will include restoration of pavement, curb, gutter, and road along Cold Spring Road.

Panel 9 in **Appendix I** continues from the west end of Panel 8. As shown in Panel 9, Cold Spring Road and Fenway Drive are two-lane, two-way roads. The land use around the route alternative in Panel 9 is primarily residential, with public use areas. From the east end of Panel 9, the Water Supply Pipeline lies within the westbound lane of Cold Spring Road. The pipeline continues past the intersection of Cold Spring Road and Sunny Slope Road and enters Parcel NBC 1241994 (owned by the New Berlin Public Schools) near the northern boundary of the property. The pipeline follows the northern boundary of Parcel NBC 1241994 for 1,600 feet. At this point, the pipeline jogs around the north side of the track and football field. The pipeline turns southwest and heads towards the western boundary of Parcel NBC 1241994. The pipeline then turns west and exits Parcel NBC 1241994 back onto public right-of-way. The pipeline then lies in the westbound lane of Fenway Drive for the remainder of Panel 9.

At the intersection of Cold Spring and Sunny Slope Roads, 100 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on Sunny Slope Road. In Parcel NBC 1241994, 130 feet west of the intersection of Cold Spring Road and Sunny Slope Road, 350 linear feet of pipe will be installed via HDD. This construction method is used to avoid impacts to a waterway. Construction activities along Cold Spring Road will require full closure with detours for through traffic along this portion of Cold Spring Road. Temporary access to residential areas on both the north and south sides of Cold Spring Road will be provided where required. Construction will include restoration of pavement, curb, gutter, and road along Cold Spring Road. Full access to all portions outside of the construction limits on Parcel NBC 1241994 will be provided. Any disturbance within the easement will be restored in-kind. Temporary access to residential areas on the north side of Fenway Drive will be provided where required. Construction will include restoration of pavement, curb, gutter, and road along Fenway Drive. See photo 51 for visual reference.



Photo 51

Looking west at the intersection of Cold Spring Road and Sunny Slope Road

Fenway Drive Segment

Panel 10 in **Appendix I** continues from the west end of Panel 9. As shown in Panel 10, Fenway, Regal, and Mayflower Drives are two-lane, two-way roads. The land use around the route alternative in Panel 10 is primarily residential areas. At the east end of Panel 10, the Water Supply Pipeline lies within the westbound lane of Fenway Drive. At the intersection of Fenway and Regal Drives, the pipeline turns north to lie within the northbound lane of Regal Drive. This alignment is followed for 270 feet to the intersection of Regal Drive and Fenway Drive. At this point, the pipeline turns west to lie within the westbound lane. This alignment is followed until the intersection of Fenway and Mayflower Drives, at which point the pipeline turns northwest to lie within the westbound lane of Mayflower Drive. This alignment is followed for the remainder of Panel 10.

At the intersection of Mayflower Drive and Moorland Road, 170 linear feet of pipe casing will be installed via the jack and bore method. This construction method is used to minimize traffic disruption on Moorland Road. Construction activities along Fenway, Regal and Mayflower Drive will require full closure with detours for traffic. Temporary access to residential areas along Fenway Drive, Regal Drive, and Mayflower Drive will be provided where required. Construction will include restoration of curb, gutter, grass, and road along Fenway, Regal, and Mayflower Drives. See photo 60 for visual reference.



Photo 60

Looking east at the intersection of Mayflower Drive and Moorland Road

National Avenue Segment

Panel 11 in **Appendix I** continues from the west end of Panel 10. As shown in Panel 11, Mayflower and Church Drives are two-lane, two-way roads. National Avenue is a four-lane, two-way road, while Observatory Road is a two-lane, two-way road. The land use around the route alternative in Panel 11 is primarily comprised of residential and commercial areas. On the east end of Panel 11, the pipeline lies within the westbound lane of Mayflower Drive. This alignment is followed until the intersection of Mayflower and Church Drives. At this point, the pipeline turns north to lie

within the southbound lane of Church Drive. This alignment is followed until the intersection of Church Drive and National Avenue, at which point the alignment turns southwest within the easternmost northbound lane of National Avenue. This alignment is followed for 2,850 feet at which point the alignment shifts north to lie underneath the sidewalk, northwest of the southbound lane. This alignment is followed until the intersection of National Avenue and Observatory Road, at which point the pipeline turns north to lie within the grass on the east side of the road. This alignment is followed for 550 feet, at which point the pipeline shifts west to lie within the southbound lane. This alignment is followed for the remainder of Panel 11.

Approximately 1,000 feet northeast of the intersection of National Avenue and Observatory Road, 120 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to cross National Avenue and minimize traffic disruption. Construction activities along Mayflower Drive will require the closure of the westbound lane, while traffic will be controlled to the single eastbound lane. Construction activities along Church Drive will require the closure of the southbound lane, while traffic will be controlled in a single northbound lane. Construction activities along the easternmost northbound lane of National Avenue will require closure of the lane, while traffic will be controlled in the single westernmost northbound lane. Construction activities along the sidewalk northwest of the southbound lanes of National Avenue will require the closure of the westernmost southbound lane, while traffic will be controlled in the single easternmost southbound lane. Construction activities along Observatory Road will require the full closure of the road, requiring a detour. Temporary access to residential and commercial areas will be provided where required. Construction will include restoration of grass and road along Mayflower Drive and Church Drive. Construction will also include the restoration of curb, grass, and road along National Avenue. Construction will also include restoration of pavement, curb, gutter, grass and road along Observatory Road. See photos 64 through 67 for visual reference.



Photo 64

*Looking northwest at the intersection of
Church Drive and National Avenue*



Photo 65

*Looking southwest at the intersection of
Church Drive and National Avenue*



*Photo 66
Looking west across National Avenue 2,850
feet southwest of the intersection of National
Avenue and Church Drive*



*Photo 67
Looking northwest at the intersection of
Observatory Road and National Avenue*

Observatory Road Segment

Panel 12 in **Appendix I** continues from the west end of Panel 11. As shown in Panel 12, Observatory Road is a two-lane, two-way road. The land use around the route alternative in Panel 12 is primarily residential and agricultural areas. For the entirety of Panel 12, the Water Supply Pipeline lies within the eastbound lane of Observatory Road.

At the intersection of Observatory Road and Calhoun Road, 100 linear feet of pipe casing will be installed via the jack and bore method. This construction method is used to minimize traffic disruption on Calhoun Road. Approximately 30 feet east of the intersection of Observatory Road and Johns Drive, 260 linear feet of pipe will be installed via HDD. This construction method is used to avoid impacts to a creek and culvert. For the entirety of Panel 12, construction activities will require the full closure of Observatory Road, requiring a detour. Temporary access to residential and agricultural areas on Observatory Road will be provided where required. Construction will include restoration of curb, grass and road along Observatory Road. See photos 70 and 71 for visual reference.



Photo 70
Looking east at the intersection of
Observatory Road and Calhoun Road



Photo 71
Looking west along Observatory Road at the
waterway 1,000 feet west of Calhoun Road

Panel 13 in **Appendix I** continues from the west end of Panel 12. As shown in Panel 13, Observatory Road is a two-lane, two-way road. The land use around the route alternative in Panel 13 is primarily residential and agricultural areas. From the east edge of Panel 13, the Water Supply Pipeline lies within the eastbound lane of Observatory Road. This alignment is followed for 3,500 feet, at which point the pipeline shifts west to lie within the westbound lane. This alignment is followed for the remainder of Panel 13.

At a point 1,500 feet west of the intersection of Observatory Road and Woelfel Road, 350 linear feet of pipe will be installed via HDD. This construction method is used to avoid impacts to a creek and culvert. For the entirety of Panel 13, construction activities will require the full closure of Observatory Road, requiring a detour. Temporary access to residential and agricultural areas on Observatory Road will be provided where required. Construction will include restoration of pavement, grass and road along Observatory Road. See photo 75 for visual reference.

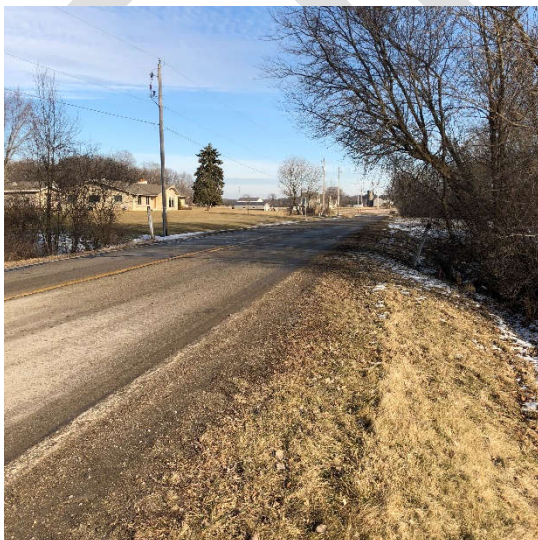


Photo 75
Looking east along Observatory Road at the
waterway 1,800 feet west of the intersection
of Observatory Road and Woelfel Road

Panel 14 in **Appendix I** continues from the southwest end of Panel 13. As shown in Panel 14, Observatory Road is a two-lane, two-way road, while Racine Avenue is a two-lane, two-way road. The land use around the route alternative in Panel 14 is primarily residential and agricultural areas. From the east edge of Panel 14, the Water Supply Pipeline lies within the westbound lane of Observatory Road. This alignment is followed for 3,300 feet to the intersection of Observatory Road and Racine Avenue. At this point the Water Supply Pipeline turns north to converge into the Common Corridor and lies within the southbound shoulder. This alignment is followed for the remainder of Panel 14.

At the intersection of Observatory Road and Racine Avenue, 80 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on Racine Avenue. Construction activities along Observatory Road will require full closure of Observatory Road with detours for through traffic. Construction activities within the shoulder of the southbound lane of Racine Avenue will require the closure of the southbound lane and shoulder of Racine Avenue, while traffic will be controlled in the northbound lane and shoulder. Temporary access to residential and agricultural areas on Observatory Road will be provided where required. Construction will include restoration of pavement, grass and road along Observatory Road and Racine Avenue. See photo 79 for visual reference.



Photo 79

Looking northwest along Racine Avenue 200 feet southeast of the intersection of Observatory Road and Racine Avenue

Racine Avenue Segment

Panel 15 in **Appendix I** continues from the west end of Panel 14. As shown in Panel 15, Racine Avenue is a two-lane, two-way roadway. The land use around the route alternative in Panel 15 is primarily residential and agricultural areas. From the southeast edge of Panel 15, the pipelines lie within the southbound shoulder of Racine Avenue. This alignment is followed for 1,000 feet, at which point the pipelines shift west 15 feet to lie outside pavement limits. This alignment is followed for the remainder of Panel 15.

Construction activities within the shoulder of the southbound lane of Racine Avenue will require the closure of the southbound lane and shoulder of Racine Avenue, while traffic will be controlled in the northbound lane. Construction activities outside the road on the west side of Racine Avenue will require the closure of the southbound shoulder of Racine Avenue, keeping both northbound and southbound lanes open. Temporary access to residential and agricultural areas on the west side of Racine Avenue will be provided where required. Construction will include restoration of grass and road along Racine Avenue.

Panel 16 in **Appendix I** continues from the west end of Panel 15. As shown in panel 16, Racine Avenue is a two-lane, two-way roadway. The land use around the route alternative in Panel 16 is primarily residential and agricultural areas. On the southeast side of Panel 16, the pipelines lie outside of pavement limits on the west side of Racine Avenue. This alignment is followed for 2,900 feet, at which point the pipelines shift east to lie within the northbound shoulder. This alignment is followed for the remainder of Panel 16.

Construction activities outside the road on the west side of Racine Avenue will require the closure of the southbound shoulder of Racine Avenue, keeping both northbound and southbound lanes open. Construction activities within the shoulder of the northbound lane of Racine Avenue will require the closure of the northbound lane and shoulder of Racine Avenue, while traffic will be controlled through the southbound lane and shoulder. Temporary access to residential areas on the east side and agricultural areas on the west side of Racine Avenue will be provided where required. Construction will include restoration of grass and road along Racine Avenue.

Panel 17 in **Appendix I**, refer to Panel 18 in Route Alternative M2 for description.

Sunset Drive Segment

Panel 18 in **Appendix I**, refer to Panel 19 in Route Alternative M2 for description.

Panel 19 in **Appendix I**, refer to Panel 20 in Route Alternative M2 for description.

ROUTE ALTERNATIVE M3

The narrative for the Water Supply Pipeline alignment of Route Alternative M3 is presented below following the flow path, beginning at the anticipated connection to the MWW distribution system and ending at the connection to WWU's distribution system in Waukesha. Segments that are either in multiple routes or within the Common Corridor on a singular route are only described once at the segment or panel that first occurs per the direction of flow. The discussion provides the rationale for the preliminary horizontal alignment, traffic control strategies, and trenchless crossing methods. The photos provided for visual reference are numbered from east to west, south to north, and by time of year taken, starting at the anticipated connection to the water supplier in Milwaukee.

Howard Avenue Segment

Panel 1 in **Appendix I**, refer to Panel 1 in Route Alternative M2 for description.

Forest Home Avenue Segment

Panel 2 in **Appendix I**, refer to Panel 2 in Route Alternative M2 for description.

Cold Spring Road Segment

Panel 3 in **Appendix I**, refer to Panel 3 in Route Alternative M2 for description.

Panel 4 in **Appendix I**, refer to Panel 4 in Route Alternative M2 for description.

Panel 5 in **Appendix I**, refer to Panel 5 in Route Alternative M2 for description.

Panel 6 in **Appendix I**, refer to Panel 6 in Route Alternative M2 for description.

Beloit Avenue Segment

Panel 7 in **Appendix I** continues from the west end of Panel 6. As shown in Panel 7, Cold Spring and Beloit Roads are two-lane, two-way roads. The land use around the route alternative in Panel 7 is primarily residential areas. From the east edge of Panel 7, the Water Supply Pipeline lies within the eastbound lane of Cold Spring Road until the intersection with Beloit Road. The alignment turns southwest on Beloit Road to lie outside pavement limits, but within the right-of-way to minimize pavement replacement. Approximately 180 feet southwest of the intersection of Beloit Road and 124th Street, the pipeline turns west and lies within the southbound lane and shoulder for the remainder of Panel 7. The pipeline shifts west to the southbound lane and shoulder to avoid wetlands, overhead utilities, and a drainage ditch.

Approximately 60 feet northeast of the intersection of Beloit Road and 124th Street, 160 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on 124th Street. Construction activities on the south side of Cold Spring Road will require the full closure of this portion of Cold Spring Road, requiring a detour. Construction activities on the south side of Beloit Road will require the use of northbound lane shoulder, while traffic will be controlled through the northbound and southbound lanes. Construction activities within the southbound shoulder lane on Beloit Road will require closure of the southbound lane, while traffic will be controlled within the northbound lane along this portion of Beloit Road. Temporary access to residential areas on Cold Spring Road and Beloit Road will be provided where required. Construction will include restoration of pavement, grass, shoulder, and road along Beloit Road. See photos 39 and 44 for visual reference.



Photo 39

Looking west at the intersection of Cold Spring Road and Beloit Road



Photo 44

Looking southwest at the intersection of Beloit Road and 124th Street

Panel 8 in **Appendix I** continues from the west end of Panel 7. As shown in Panel 8, Beloit Road is a two-lane, two-way road. The land use around the route alternative in Panel 8 is primarily residential areas. On the northeast side of Panel 8, the Water Supply Pipeline lies within the southbound lane shoulder and outside pavement limits of Beloit Road. Approximately 50 feet northeast of the Interstate 43 underpass, the pipeline shifts to lie within the southbound lane of Beloit Road. About 500 feet southwest of the intersection of Beloit Road and the Interstate 43 underpass, the pipeline turns west on Beloit Road to lie outside pavement limits, but within the right-of-way to minimize road replacement. This alignment is followed for the remainder of Panel 8.

Approximately 15 feet northeast of the intersection of Beloit Road and Armour Avenue, 90 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on Armour Avenue. About 50 feet northeast of the Interstate 43 underpass, 790 linear feet of pipe will be installed via HDD. This construction method is used to avoid construction underneath the Interstate 43 Bridge. Construction activities outside pavement limits and southbound shoulder lane on Beloit Road will require closure of the southbound lane, while traffic will be controlled within the northbound lane along this portion of Beloit Road. Temporary access to residential areas on the north side of Beloit Road will be provided where required. Construction will include restoration of the pavement, grass, shoulder, and road along Beloit Road. See photos 47 and 48 for visual reference.



Photo 47

Looking southwest at the intersection of Beloit Road and Armour Avenue



Photo 48

Looking southwest along Beloit Road to the Interstate 43 highway underpass

Panel 9 in **Appendix I** continues from the west end of Panel 8. As shown in Panel 9, Beloit Road is a two-lane, two-way road. The land use around the route alternative in Panel 9 is primarily residential areas. On the northeast side of panel 9, the Water Supply Pipeline lies within the southbound shoulder of Beloit Road. Approximately 380 feet east of the intersection of Beloit Road and Sunny Slope Road, the pipeline shifts south to lie within the southbound lane of Beloit Road. About 150 feet west of the intersection of Beloit Road and Sunny Slope Road, the pipeline turns north of Beloit Road and lies outside pavement limits, but within the right-of-way to minimize road replacement. This alignment is followed for the remainder of Panel 9.

Approximately 20 feet east of the intersection of Beloit Road and Sunny Slope Road, 140 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on Sunny Slope Road. For the entirety of Panel 9, construction activities will require the full closure of Beloit Road, requiring a detour. Temporary access to residential areas on Beloit Road will be provided where required. Construction will include restoration of the pavement, curb, grass, shoulder, and road along Beloit Road. See photo 52 for visual reference.



Photo 52

Looking west at the intersection of Beloit Road and Sunny Slope Road

Panel 10 in **Appendix I** continues from the west end of Panel 9. As shown in Panel 10, Beloit Road is a two-lane, two-way road. Beloit Road turns into a four-lane, two-way divided road west of the Interstate 43 underpass. The land use around the route alternative in Panel 10 is primarily commercial with light residential areas. On the east side of Panel 10, the Water Supply Pipeline lies outside pavement limits, but within the right-of-way to minimize pavement replacement. Approximately 110 feet east of the Interstate 43 underpass, the pipeline shifts south to lie within the westbound lane until 50 feet west of the Interstate 43 underpass. Here the pipeline turns north on Beloit Road to lie within the northernmost westbound lane for the remainder of Panel 10.

About 50 feet east of the Interstate 43 underpass, 290 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on Beloit Road. Approximately 50 feet east of the intersection of Beloit Road and Moorland Road, 200 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on Moorland Road. Construction activities outside of pavement limits, north of Beloit Road will require the use of the westbound lane shoulder, traffic will be controlled through the westbound and eastbound lanes along Beloit Road. For the entirety of Panel 10, construction activities will require the full closure of Beloit Road, requiring a detour. Temporary access to commercial and residential areas on the north side of Beloit Road will be provided where required. Construction will include restoration of the pavement, sidewalk, curb, gutter, grass, shoulder, and road along Beloit Road. See photos 57 and 61 for visual reference.



Photo 57

*Looking west along Beloit Road to the
Interstate 43 highway underpass*



Photo 61

*Looking southwest at the intersection of Beloit
Road and Moorland Road*

Panel 11 in **Appendix I** continues from the west end of Panel 10. At the beginning of this panel, 30 linear feet of pipe casing has been discussed in Panel 10. Starting southwest of this point on Panel 11, Beloit Road is a four-lane, two-way divided road. Approximately 300 feet east of Towne Road, Beloit Road transitions to a two-lane, two-way road. The land use around the route alternative in Panel 11 is primarily industrial with light commercial and residential areas. On the northeast side of Panel 11, the Water Supply Pipeline lies within the northernmost westbound lane of Beloit Road. About 300 feet east of Towne Road, Beloit Road at the Beloit Road transition, the pipeline maintains the horizontal offset from the centerline and lies outside pavement limits but within the right-of-way. Approximately 610 feet west of the intersection of Beloit Road and Towne Drive, the pipeline turns south and lies south of Beloit Road, outside pavement limits for the remainder of Panel 11. The pipeline shifts south to lie south of Beloit Road to avoid overhead utilities.

Approximately 550 feet west of the intersection of Beloit Road and Moorland Road, 410 linear feet of pipe will be installed via HDD. This construction method is used to minimize impacts to the creek. Construction activities within the westbound lane of Beloit Road will require full closure of the westbound lanes, while traffic will be controlled through the eastbound lanes for this portion of Beloit Road. For the entirety of Panel 11, construction activities will require the full closure of Beloit Road, requiring a detour. Temporary access to industrial and commercial areas on Beloit Road will be provided where required and no temporary access for residential properties will be required. Construction will include restoration of the pavement, curb, gutter, road, shoulder, and grass along Beloit Road. See photos 62 and 63 for visual reference.



Photo 62

Looking southwest along Beloit Road to the waterway 600 feet west of the intersection of Beloit Road and Moorland Road



Photo 63

Looking southwest along Beloit Road to the waterway 600 feet west of the intersection of Beloit Road and Moorland Road

Panel 12 in **Appendix I** continues from the west end of Panel 11. As shown in Panel 12, Beloit Road is a two-lane, two-way road. The land use around the route alternative in Panel 12 is primarily residential with light agricultural areas. On the east side of Panel 12, the Water Supply Pipeline lies south of Beloit Road outside pavement limits but within the right-of-way. Immediately at the start of this panel, the pipeline turns west to lie within the westbound lane of Beloit Road. Approximately 290 feet west of the intersection of Beloit Road and Calhoun Road, the pipeline turns south to lie within the eastbound lane of Beloit Road. This alignment is followed for the remainder of Panel 12.

Approximately 960 feet east of the intersection of Beloit Road and Calhoun Road, 370 linear feet of pipe will be installed by via HDD. This construction method is used to minimize impacts to the creek. Approximately 40 feet east of the intersection of Beloit Road and Calhoun Road, 130 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on Calhoun Road. About 430 feet west of the intersection of Beloit Road and Calhoun Road, 350 linear feet of pipe will be installed via HDD. This construction method is used to minimize impacts to the creek and culvert. For the entirety of Panel 12, construction activities will require the full closure of Beloit Road, requiring a detour. Temporary access to residential and agricultural areas of Beloit Road will be provided where required. Construction will include restoration of the road, shoulder, and grass along Beloit Road. See photos 72 through 74 for visual reference.



Photo 72

Looking west at the waterway 1,000 feet east of the intersection of Beloit Road and Calhoun Road



Photo 73

Looking west at the intersection of Beloit Road and Calhoun Road



Photo 74

Looking west at the waterway 450 feet west of the intersection of Beloit Road and Calhoun Road

Panel 13 in **Appendix I** continues from the west end of Panel 12. As shown in Panel 13, Beloit Road and National Avenue are both two-lane, two-way roads. The land use around the route alternative in Panel 13 is primarily residential areas. On the east side of Panel 13, the Water Supply Pipeline lies within the westbound lane of Beloit

Road until the intersection of Beloit Road and National Avenue. At this point the pipeline turns southwest and lies within National Avenue northbound shoulder for the remainder of Panel 13.

Construction activities along Beloit Road will require full road closure with detours for through traffic along this portion of Beloit Road. Construction activities within the National Avenue northbound shoulder will require closure of northbound lane, while traffic on the northbound and southbound lanes will be controlled through the southbound lanes for this portion of National Avenue. Temporary access to residential areas on Beloit Road and National Avenue will be provided where required. Construction will include restoration of the grass, shoulder, and road along Beloit Road and National Avenue.

National Avenue Segment

Panel 14 in **Appendix I** continues from the west end of Panel 13. As shown in Panel 14, National Avenue is a two-lane, two-way road and Racine Avenue is a four-lane, two-way road with a center median. The land use around the route alternative in Panel 14 is primarily residential and agricultural areas. On the northeast side of Panel 14, the Water Supply Pipeline lies within the northbound lane shoulder and outside of pavement limits, but within the right-of-way to minimize the road replacement. Approximately 810 feet southwest of the intersection of National Avenue and Egofske Road, the pipeline turns west and lies within Parcel NBC 1268960. The pipeline continues west for 1,100 feet, exits Parcel NBC 1268960, turns north to converge into the Common Corridor and lie within the southbound shoulder of Racine Avenue. This alignment is followed for the remainder of Panel 14. A minimum 50 foot permanent easement spanning across the identified parcel will be required.

Approximately 810 feet southwest of the intersection of National Avenue and Egofske Road, 100 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to avoid traffic disruption on National Avenue while crossing National Avenue to Parcel NBC 1268960. At the Racine Avenue crossing from Parcel NBC 1268960, 100 linear feet of pipe casing will be installed by using the jack and bore method. This construction method is used to minimize traffic disruption on Racine Avenue. Construction activities on the south side of National Avenue will require closure of the northbound lane, while traffic will be controlled to the southbound lane along this portion of National Avenue. Construction activities within Racine Avenue southbound lane shoulder will require closure of the westernmost southbound lane, while traffic will be controlled to one southbound lane, while keeping the northbound lanes on the east side of the road open. Temporary access to residential areas on National Avenue and Racine Avenue will be provided where required. Construction will include restoration of the pavement, curb, gutter, shoulder, grass, and road along National Avenue and Racine Avenue. See photos 76 through 78 for visual reference.



Photo 76

Looking east across National Avenue 1,350 feet northeast of the crossing of National Avenue and Racine Avenue



Photo 77

Looking east across parcel NBC 1268960 800 feet north of the intersection of Racine Avenue and National Avenue



Photo 78

Looking north along Racine Avenue 800 feet north of the intersection of Racine Avenue and National Avenue

Racine Avenue Segment

Panel 15 in **Appendix I** continues from the north end of Panel 14. As shown in Panel 15, Racine Avenue is a two-lane, two-way road. The land use around the route alternative in Panel 15 is primarily residential with light agricultural areas. For the entirety of Panel 15, the pipeline lie within the southbound lane and shoulder of Racine Avenue.

Construction activities within Racine Avenue southbound lane shoulder, along the four-lane portion of the road, will require closure of the westernmost southbound lane, while traffic will be controlled to one southbound lane, while keeping the northbound lane on the east side of the road open to traffic. Construction activities within Racine Avenue southbound lane shoulder, along the two-lane portion of the road, will require closure of the southbound lane, while

traffic will be controlled within the northbound lane along this portion of Racine Avenue. Temporary access to residential and agricultural areas on the west side of Racine Avenue will be provided where required. Construction will include restoration of the shoulder and grass along Racine Avenue.

Panel 16 in **Appendix I** continues from the west end of Panel 15. As shown in Panel 16, Racine Avenue is a two-lane, two-way road. The land use around the route alternative in Panel 16 is primarily agricultural and light residential areas. For the entirety of Panel 16, the pipeline lies outside of pavement limits and within the southbound lane shoulder of Racine Avenue. This alignment is followed for the remainder of Panel 16.

Construction activities within Racine Avenue southbound lane shoulder will require closure of the southbound lane, while traffic will be controlled within the northbound along this portion of Racine Avenue. Temporary access to residential and agricultural areas on the west side of Racine Avenue will be provided where required. Construction will include restoration of the pavement, shoulder and grass along Racine Avenue.

Panel 17 in **Appendix I** continues from the north end of Panel 16. As shown in Panel 17, Racine Avenue is a two-lane, two-way road. The land use around the route alternative in Panel 17 is primarily agricultural areas, with light residential areas. For the entirety of Panel 17, the pipeline lies outside of pavement limits and within the southbound lane shoulder of Racine Avenue, but within the right of way to minimize road replacement.

Construction activities within Racine Avenue southbound lane shoulder will require closure of the southbound lane, while traffic will be controlled within the northbound lane along this portion of Racine Avenue. Temporary access to residential and agricultural areas on the west side of Racine Avenue will be provided where required. Construction will include restoration of the grass and shoulder along Racine Avenue.

Panel 18 in **Appendix I**, refer to Panel 15 in Route Alternative M2 for description.

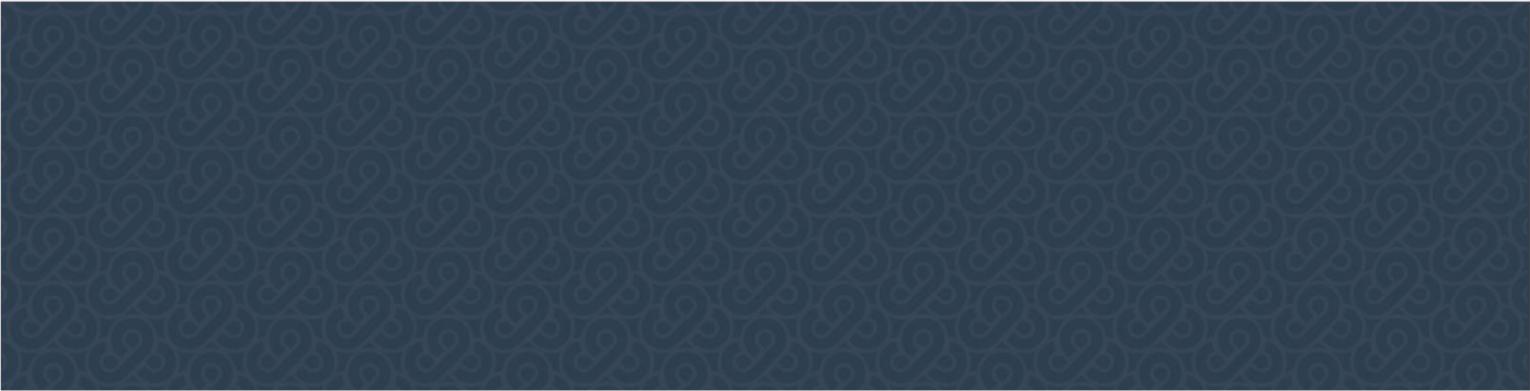
Panel 19 in **Appendix I**, refer to Panel 16 in Route Alternative M2 for description.

Panel 20 in **Appendix I**, refer to Panel 17 in Route Alternative M1 for description.

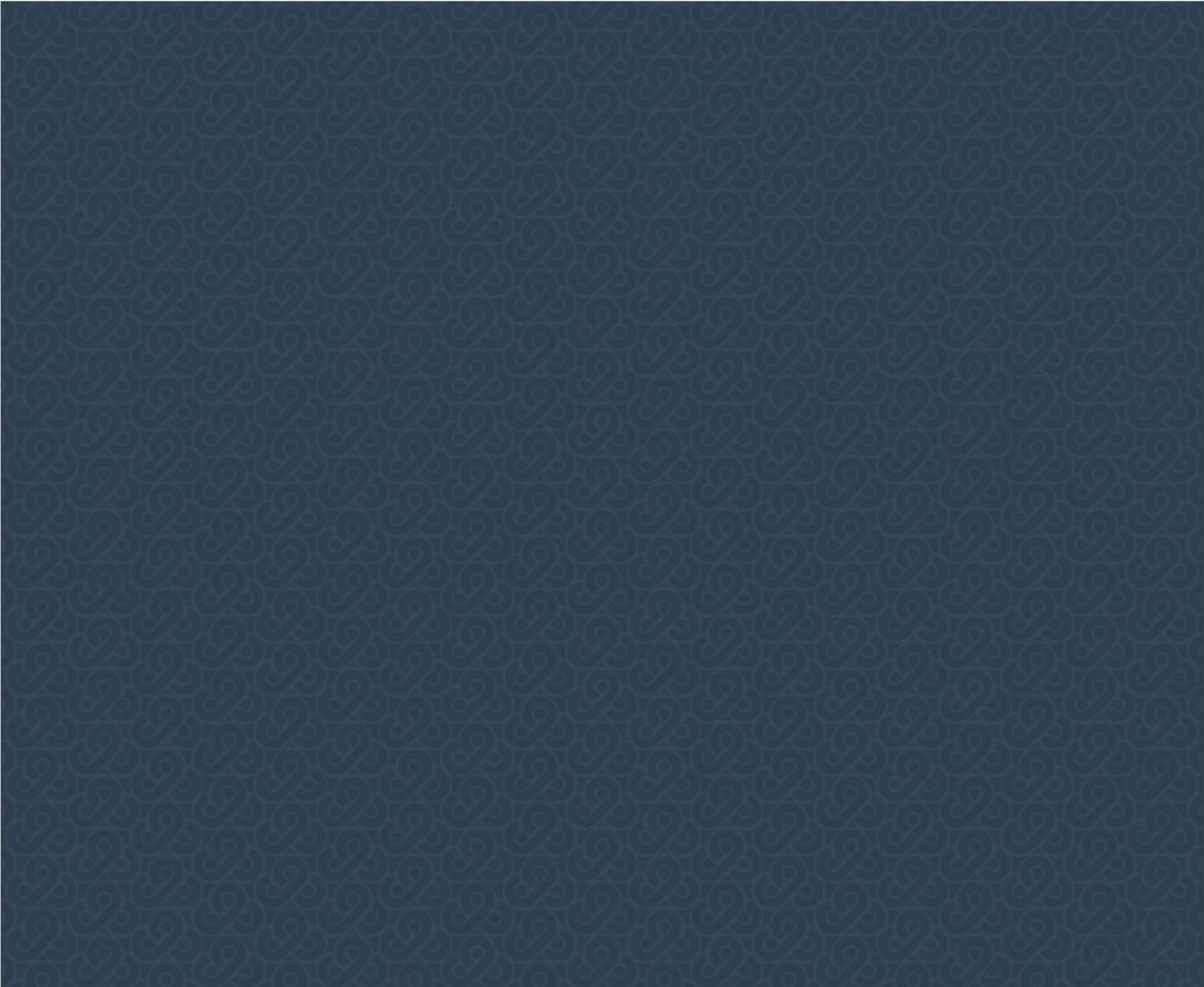
Sunset Drive Segment

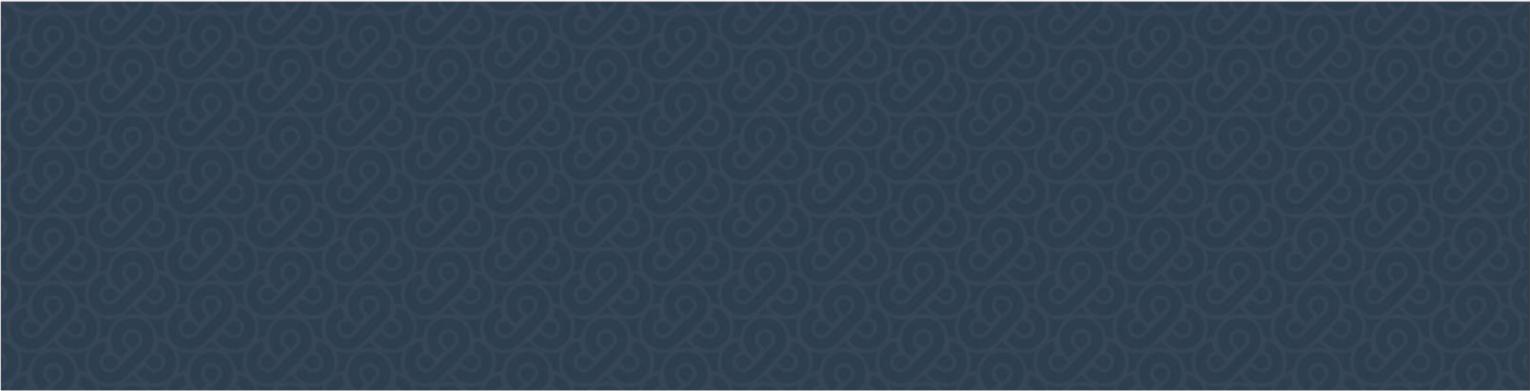
Panel 21 in **Appendix I**, refer to Panel 18 in Route Alternative M1 for description.

Panel 22 in **Appendix I**, refer to Panel 19 in Route Alternative M1 for description.

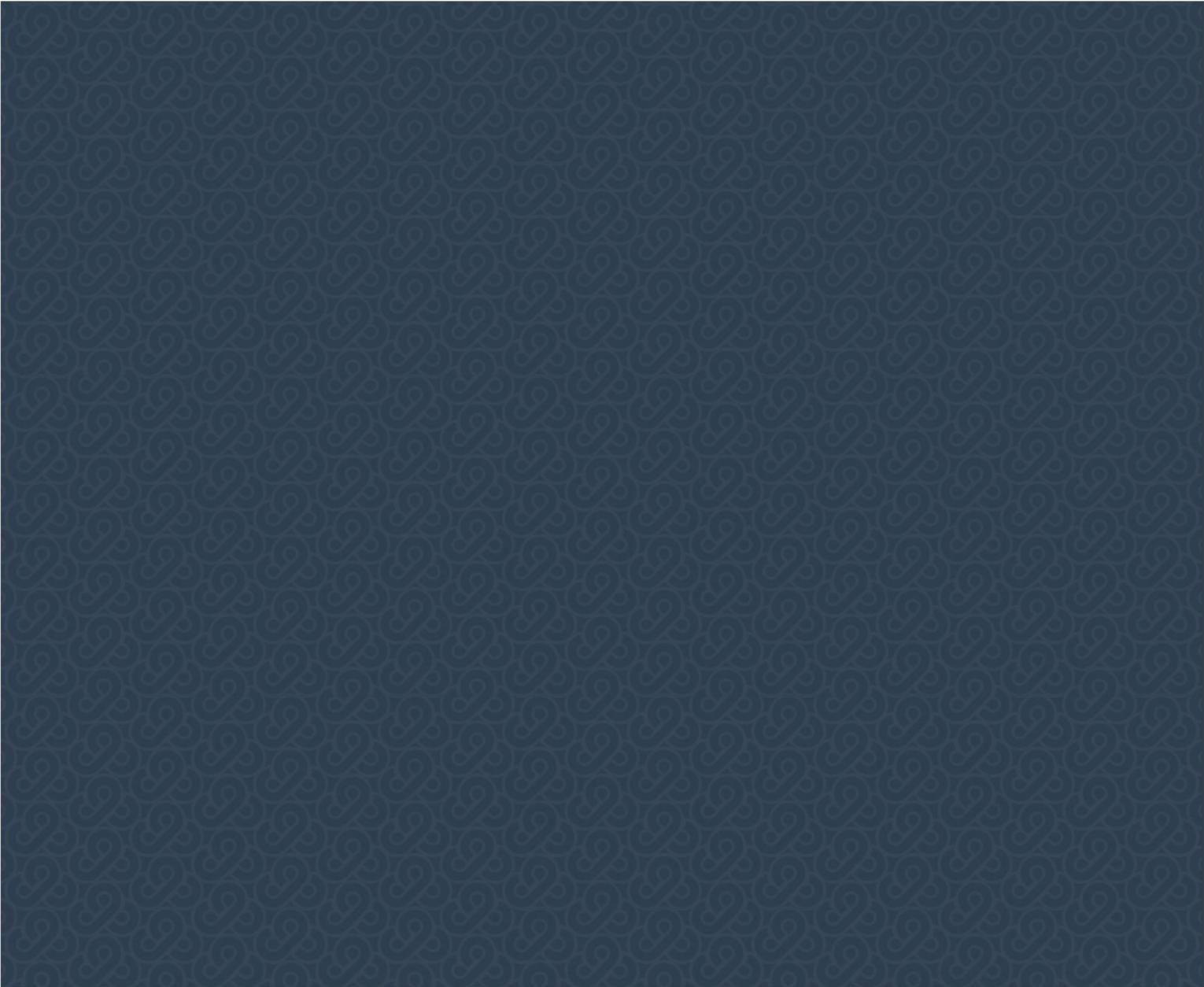


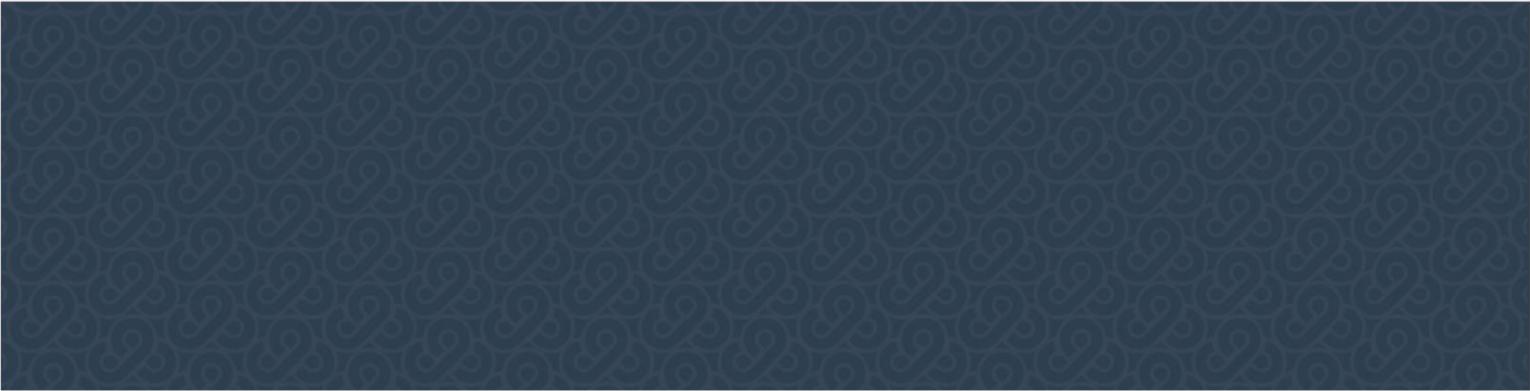
**Appendix B – Geotechnical Soil
Analysis Technical Memorandum
(Included Electronically)**



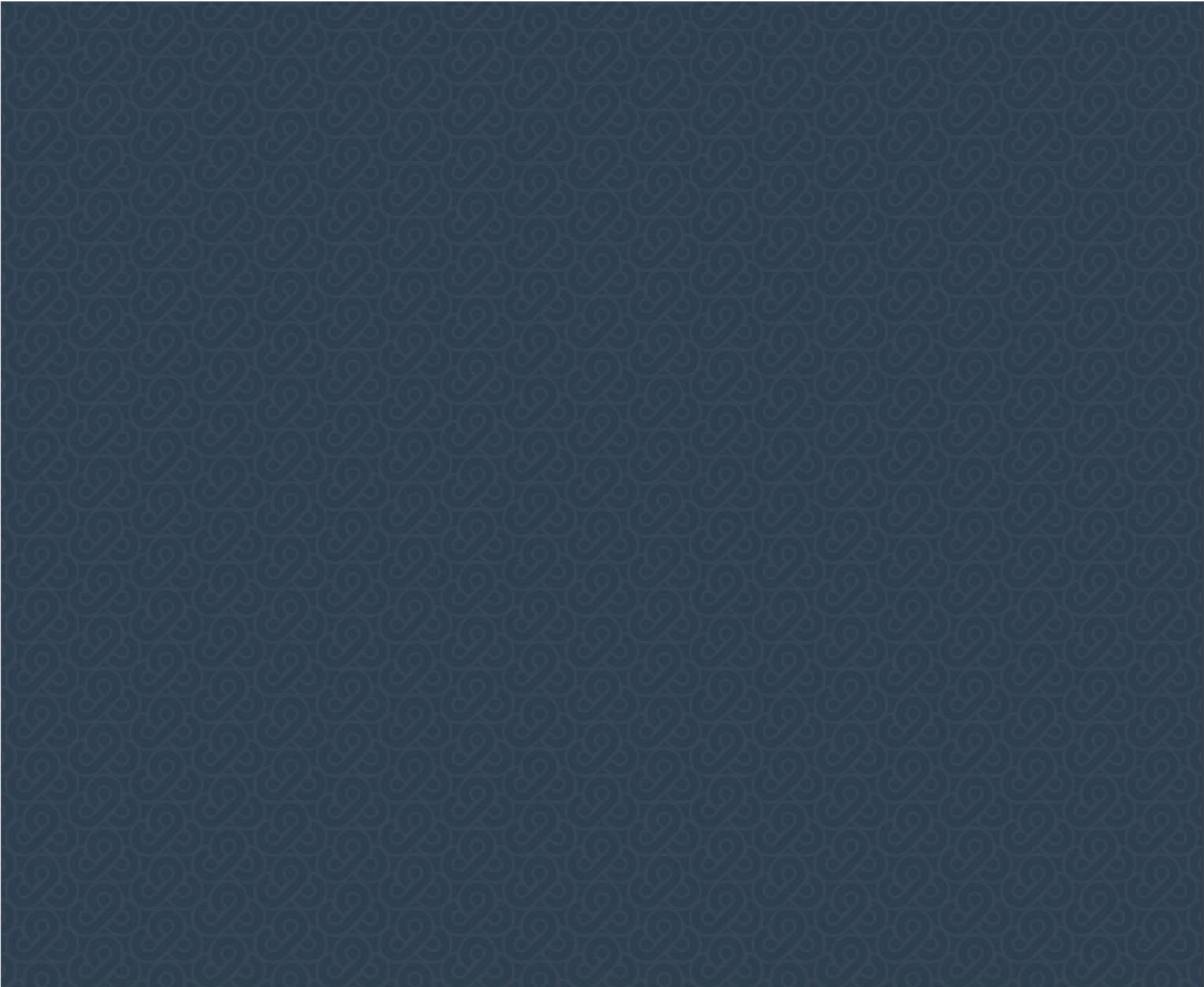


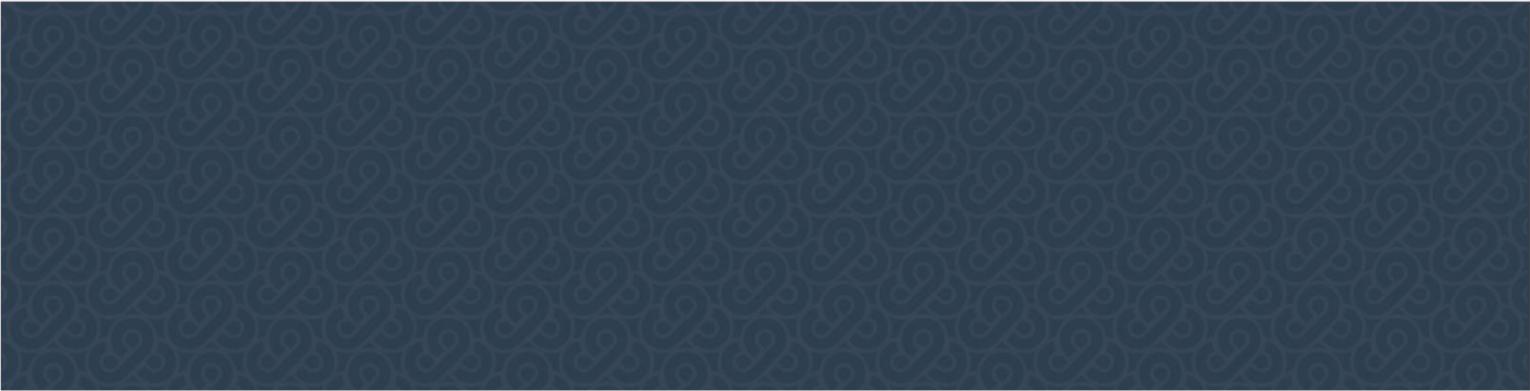
Appendix C – Contaminated Materials
Technical Memorandum (*Included*
***Electronically*)**



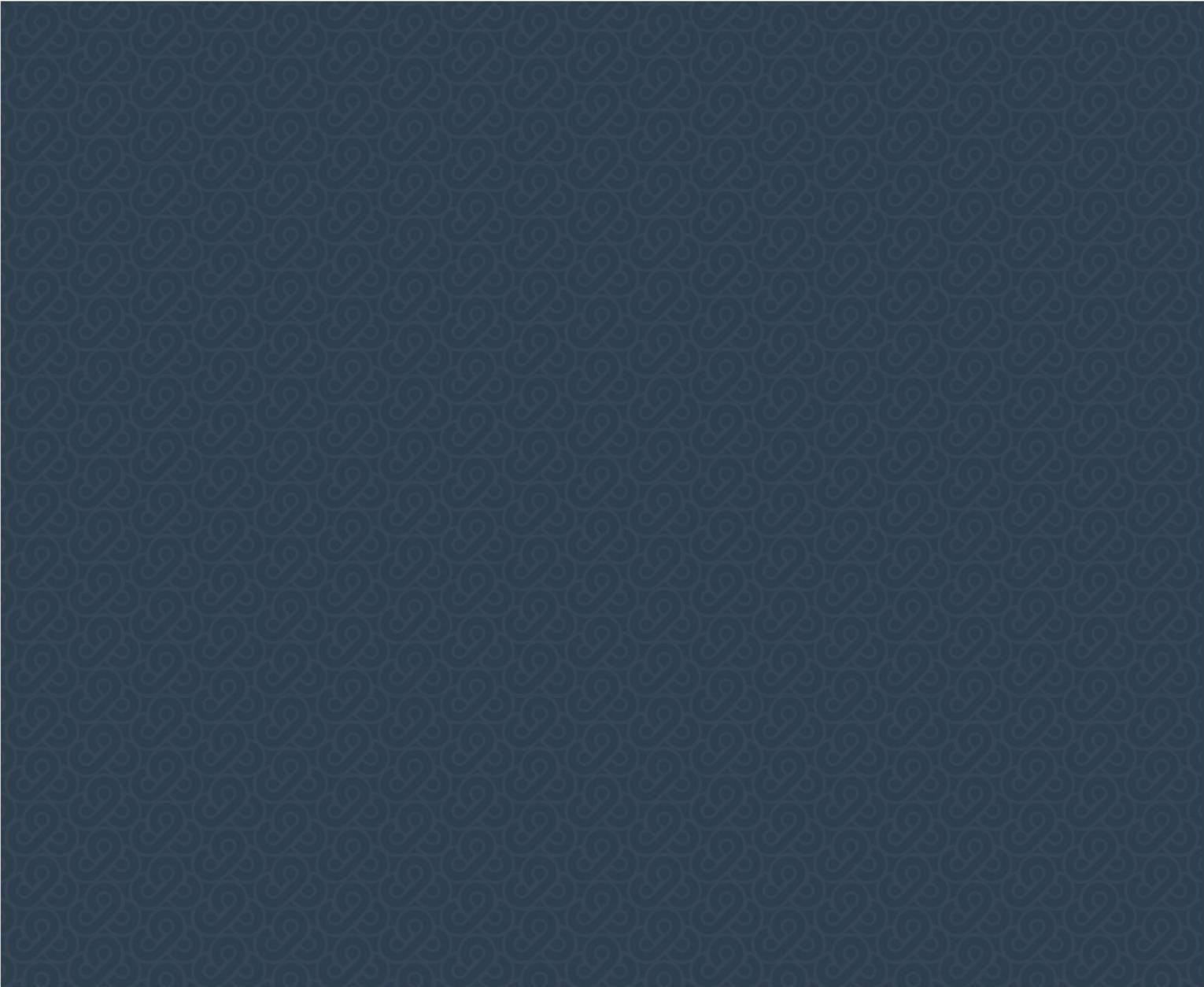


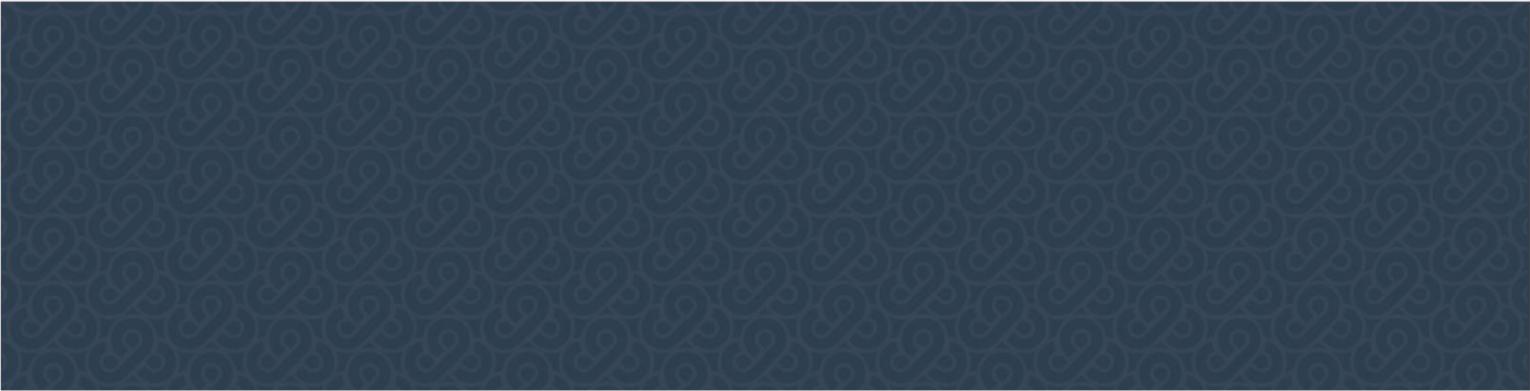
**Appendix D – Wetlands and
Waterways Technical Memorandum**
(Included Electronically)



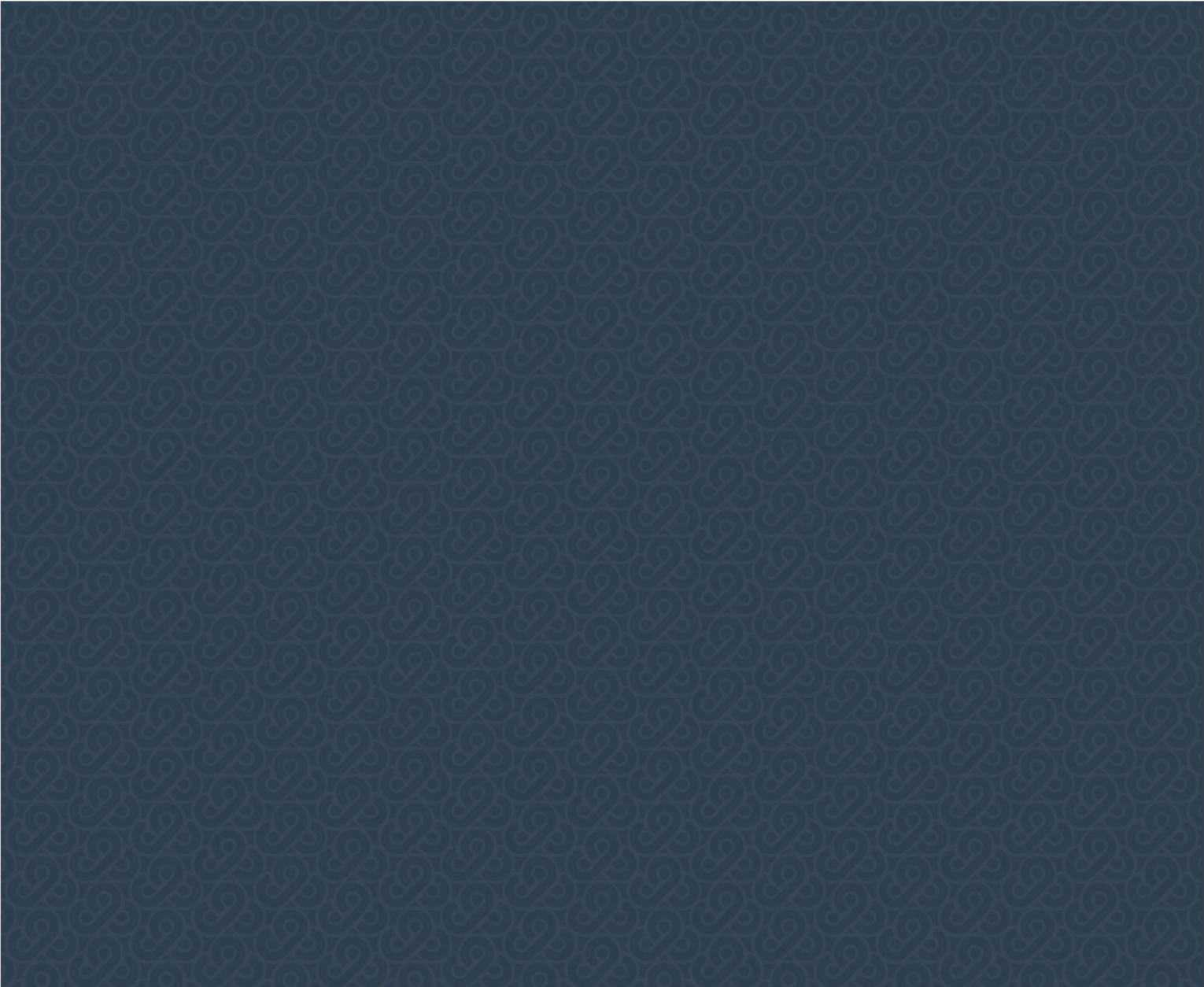


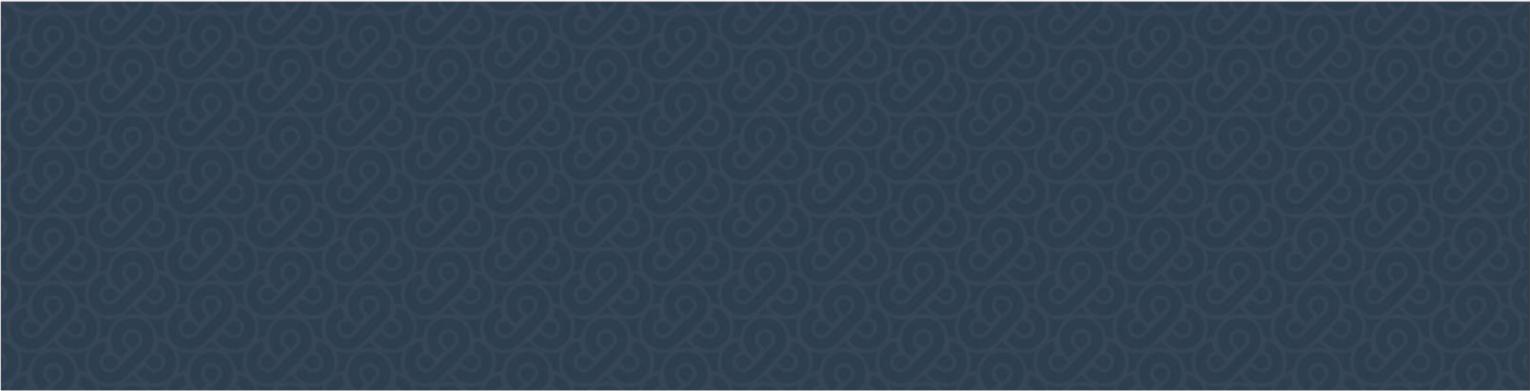
Appendix E – Endangered Resources
Technical Memorandum (*Included*
***Electronically*)**



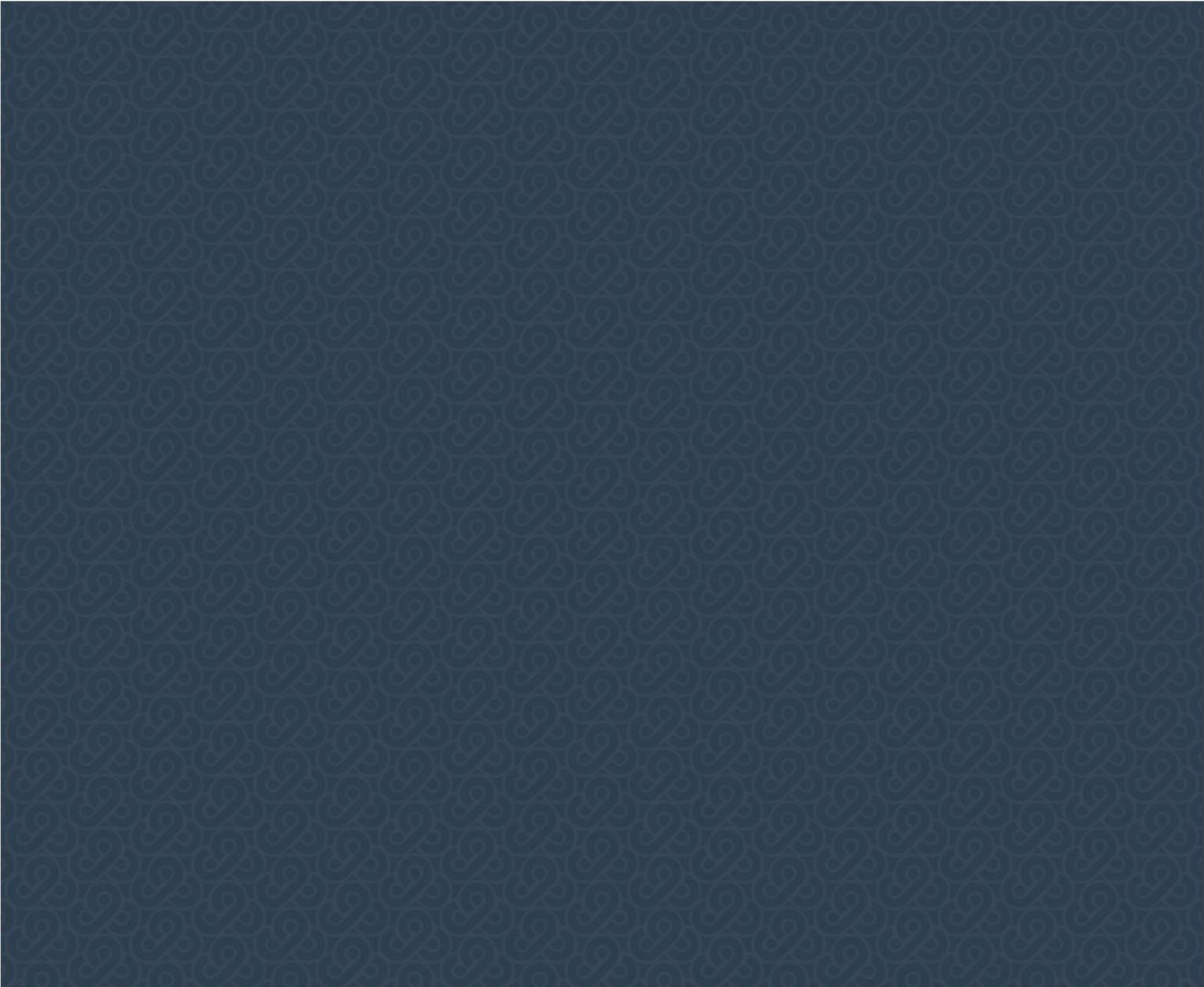


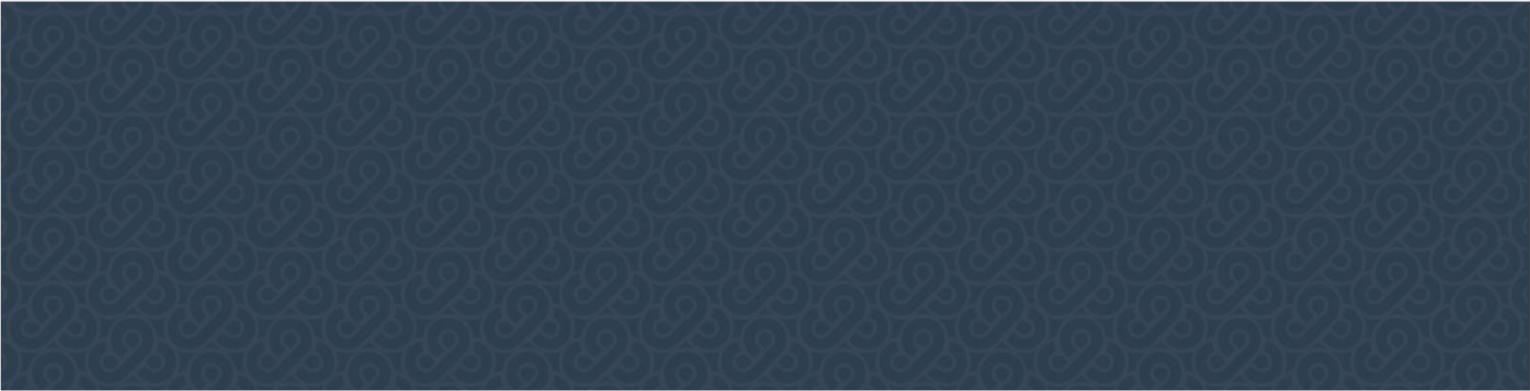
Appendix F – Cultural Resources
Technical Memorandum (*Included*
***Electronically*)**





Appendix G – Agricultural Resources
Technical Memorandum (*Included*
***Electronically*)**





Appendix H – Transportation
Assessment Technical Memorandum
(Included Electronically)



**Appendix I – Route Alternatives M1,
M2, and M3 Preliminary Horizontal
Alignments *(Included Electronically)***



Appendix J – Workshop and Meeting Summaries *(Included Electronically)*





GREELEY AND HANSEN

741 N. Grand Ave., Suite 308
Waukesha, WI 53186